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TREATISE

OF

Photography on Collodion.

BY

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AND

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TO

THE ARTISTS AND OPERATORS

OF THE COUNTRY,

This Work is Respectfully Dedicated, by the Authors,

IN THE HOPE THAT IT MAY BE FOUND

A USEFUL AUXILIARY IN THEIR LABORATORIES,

AND CONTRIBUTE TO

THE PERFECTION OF A MOST BEAUTIFUL AND IMPORTANT

ART.

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PREFACE.

In presenting the following pages to the public, it is from no egotistic belief on our part that our processes are infallibly the best, nor that the tone and perfection of our own practical results are the finest; but we are prompted by altogether different feelings.

The motives which have induced us to undertake this labor and work are those which embrace the general good and instruction of all artists.

Works upon this subject are in some respects deficient, by not combining practical details with the chemistry of Photography. We do not say how far we have succeeded in our aims, but we have endeavored to familiarize the subject to the understanding of the poorest operator, and still prove beneficial to the most skillful.

In the chemistry of the subject, we have used such language as will be understood, and yet be free from its nomenclature. It is designed to make the operator

practically acquainted with the nature and relations of the salts, acids, solvents, and solutions which he employs; so that his operating room shall become a little laboratory, wherein he shall understandingly prepare his chemicals, and when not in working order, correct them.

The work is the result of long practical acquaintance with the subject — of patient investigation and experiment; and it is hoped that it may supply a want which is seriously felt by the great class of Photographers.

We are under obligations to Mr. M. CARPENTER, of this city, for the use of his operating room in conducting some of our experiments, and for his politeness in affording us many facilities.

INTRODUCTION.

GENERAL THEORY OF THE COLLODION PROCESS.

COLLODION is a solution of pyroxyline or gun cotton, in a mixture of sulphuric ether and alcohol. The use of Collodion in Photography was originally suggested by M. Legray, a French artist; but Mr. Archer, of London, is the first who carried out the idea, so as to present to the photographic world a well defined process.

Collodion pictures have until recently been made generally upon glass; but lately many operators have commenced taking them upon enameled iron plates. Of these last pictures, known by the name of "Melainotypes," we will speak hereafter.

What is generally known as "Iodized Collodion," is a gun cotton solution, in which has been dissolved a certain quantity of an iodide or a bromide: the iodide of potassium for instance. If a glass or melainotype plate be coated with this iodized Collodion, and after being "set" by the evaporation of the greater part of the ether, be then dipped into a solution of nitrate of silver, the iodide of potassium and nitrate of silver will decompose each other and produce *iodide of silver*, which will be retained on the plate by the fibers of the collodion. In this state, the film will present a blue, white, or

creamy opaque appearance, according to the quantity of iodide of potassium dissolved in the plain collodion. This operation must be done in a dark room by the light of a candle. If we now expose this plate in the camera, the iodide of silver will be impressed by the rays of light, strongly in the clear parts, to a smaller extent in the darker. If we examine the plate at this moment, we find it to have the same appearance as before, presenting no trace of an image. To bring the image out, we have to submit the plate to the action of certain compounds called developers. In the Daguerreotype process, the developer is the vapor of mercury; in the collodion process, it is a solution of protosulphate of iron or of pyrogallic acid in water. If, then, we pour one of these developers on the plate, the image will make its appearance in a short time, presenting the most intensity in those places where the light was the strongest. This image is formed by metallic silver in fine powder retained on the plate by the film of collodion. At this period of the operation, we have thus on the plate metallic silver, and iodide of silver that has not been reduced by the subsequent action of the light and the developer. That which remains to be done is to take away this iodide of silver by dissolving it in a solution of cyanide of potassium, or of hyposulphite of soda. Let us now examine the picture which we have obtained, by holding it up to the light. We will observe that the light parts are opaque and the dark parts transparent. If we examine it, on the contrary, by reflection, by holding a black surface behind it, we will

find that the light parts appear white, and the dark parts black. The former appearance of the picture is called the negative, and the latter the *positive.* All collodion pictures made on transparent surfaces, such as glass or mica, present both aspects. Those made on japanned iron plates or on oil cloth, can only be viewed as positives. In practice, the name of *positives* is given to such pictures on glass, iron, etc., that are designed to be seen by reflection. On the contrary, a negative is judged of by transparence, and is a kind of *type* or *matrix*, by which pictures on paper have to be produced by means of a peculiar printing process, hereinafter described in the third part of this work.

Although a collodion glass picture presents both aspects, the positive and negative, it can not be used in both qualities; it can subserve but one purpose. A good positive picture has never opacity enough in the clear parts to be used as a negative, that is to say, for the production of positives on paper; and a negative picture viewed as a positive, that is to say, by reflection, is imperfect, owing to the absence of good blacks and details in the light parts. Both kinds of pictures are produced by the same process, but different conditions of the chemicals are required.

In the positive picture, the silver reduced on the surface of the plate is in small quantity; in the negative, it is relatively larger. This quantity of reduced silver depends on the thickness of the collodion, the strength of the bath, the time of exposure, and on the relation that exists between the different solutions used.

PART I.

CHAPTER I.

ON POSITIVE COLLODION PICTURES.

To a collodion picture, viewed by reflection, we have, in the introduction, given the name of "positive pictures." Positive pictures are generally made on glass or Japanned iron plates. In the former case they are commonly designated as "Ambrotypes," and in the latter they have received the name of "Melainotypes." Collodion pictures, called Panotypes, are made to a small extent in France. The surface used is oil cloth, or black paper, but the different manipulations are too tedious for the process to become generally adopted. For some time pictures have been made on Japanned bristol board. They are now known by the name of "Ambrographs." The effect is good, though the manipulation is uncertain.

If the asphaltum varnish (which is three parts turpentine to one part asphaltum, to which some add ether, to thin the solution) used to coat the paper, does not decompose the bath, as some claim that it does, these pictures may be successfully worked. They do not seem, however, to possess any advantages over the

Melainotype plate, and certainly possess many decided objections; from an experience of some years, we find no plates so readily handled, so economically used, so easy in manipulation, as the glass and iron plates.

Before the Melainotype plate was given to the public, *mica* was generally used for portraits designed to be put into lockets, breast-pins, and medallions. Mica is a mineral substance, of a complex composition; it contains chiefly silicate of aluminia. It cleaves very easily in thin layers, the most beautiful of which are used to receive the impression upon. But the iron plate possesses every advantage desirable for the smallest likeness, and may be fitted to the receptacle of a finger ring.

CHAPTER II.

ON THE DIFFERENT COMPOUNDS USED IN THE PRODUCTION OF POSITIVE PICTURES, AND THE RELATION EXISTING BETWEEN THEM.

BEFORE we enter upon the practical details, for the production of positive pictures, we will give, first, the preparation of the different materials to be used. These are taken in the following order: 1st, The collodion, including plain and iodized collodion; 2nd, The silver bath; 3d, The developing solution; 4th, The fixing solution; 5th, The whitening solution.

For the preparation of each of these different solutions, we will give several formulæ, such as are used

with the most success. To beginners, we recommend the use of collodion **A**, with the developing solution **A** or **E**, and the 40 grain acid silver bath. If the materials used are pure, a good picture will be obtained very easily, having fine whites and blacks, and good half-tones or middle tints. Other developers will give pictures of a different tone, which may be preferred by some; other collodion may work just as well as the one marked **A**, but its preparation may be more difficult and uncertain. Experience has taught us that one form of iodizing does not give better collodion than another, provided the chemicals are pure and used in the proper proportions. Each of the iodizing salts has, notwithstanding, its peculiar advantages.

Iodine of potassium will give a collodion that works best one day after its preparation, and will keep its qualities for about two weeks, providing the chemicals used are pure. Collodion sensitized with iodide of ammonium, will work well two or three days after it is made, but very soon will turn red, without losing its qualities; however, it will keep in good working order about the same length of time as the iodide of potassium collodion. It is more sensitive than the iodide of potassium and of cadmium. Collodion iodized with iodide of cadmium, will work best a couple of weeks after its preparation, and will keep for months, and perhaps for years. We have used in March, 1856, cadmium collodion that had been prepared in Belgium, in the month of March, the year before, by a well known European artist, Mr. Van Monckhoven. We

have said that collodion sensitized with iodide of ammonium turns red after a few days. So it does, but to a smaller extent when iodide of potassium is used. Iodide of cadmium collodion will remain white, or take only a pale yellow color. This discoloration, or reddening of the collodion, is caused by some decomposition of the iodides, by which iodine is set free. Acid alcohol or acid ether will produce it in a few hours, in circumstances in which it will take several days, if pure solvents are used. Light, warmth, and water favor this decomposition to a great extent; at an early stage it is favorable to sensitiveness, if it is not produced by acetic acid in the ether or alcohol; but at an advanced stage the collodion loses its sensitiveness almost entirely.

Bromides are used generally in collodion in combination with iodides, because the bromide of silver, which is produced by double decomposition in the silver bath, is more sensitive to the orange, red, and yellow rays, than is the iodide of silver. Bromides are not as subject to be decomposed in the collodion as the iodides. Collodion sensitized with iodide and bromide of potassium, or with iodide and bromide of ammonium, will keep longer than the one prepared by either of the iodides alone. The presence of bromide of cadmium will keep from decomposition for months that collodion which contains the very decomposable iodides of potassium and of ammonium.

We recommend beginners to use a bath containing 40 grains nitrate of silver to the ounce of water, and to use it pretty acid. Some operators recommend the

use of neutral baths, and others make them only 20 or 30 grains nitrate of silver to the ounce. These formulæ are as good as the one we recommend, if collodion and developer are in their proper relation. A very pale collodion will be difficult to work with a neutral bath, unless the developing solution is very acid. A collodion highly iodized will not work well with a 20 grain bath, and one slightly iodized will not work well with a 40 grain bath. So, to repeat, admitting that all the chemicals are of good quality, it is required, in order to work successfully, to have the collodion, silver bath, and developing solution in relation. Such remarks as will be found necessary, will be annexed to each formula.

CHAPTER III.

ON COLLODION.

THREE elements enter into the preparation of plain collodion — ether, alcohol, and soluble gun cotton, or pyroxyline.

Ether.—The purity of the Ether is a matter of great importance for the production of good collodion. It must be concentrated, free from much alcohol and water, without disagreeable smell, and free from sulphuric and acetic acid.

Three kinds of Ether are ordinarily found in commerce.

First. The common ether, which contains a certain

quantity of alcohol and water, and presents ordinarily an acid reaction with litmus paper. Ether in this state is unfit for use.

Second. The washed ether, which is ordinary ether, only agitated with a certain quantity of water, to take away the alcohol and the acid. This may be used, if it is washed so thoroughly as to present no longer an acid reaction.

Third. Ether, both washed and re-distilled on unslacked lime or on potash; which takes away the water and the essential oil, and neutralizes the remaining acidity. This is the best for use, and should always be procured, if possible.

If, however, the operator can not find any other kind, than the one spoken of as common ether, he may use it with success by letting it digest for two or three days, with good white unslacked lime. The quantity of lime to be used is two or three ounces to one pound of ether, The lime should be pulverized, put into a bottle, and the ether poured on by small quantities at a time. The effect of the unslacked lime is to absorb the water and neutralize the acid.

The ether prepared in this way is slightly alkaline, but the alkalinity is removed by the acid developed in the plain collodion, when it is kept for some time. This alkaline plain collodion is just as good to be iodized as the neutral. It must be observed, however, that it is necessary to add two or three drops tincture of iodine or hydrobromic acid to the iodized collodion, made with such collodion, in case that it remains a white color.

If it takes an orange or yellow color, it is a proof that the alkalinity has been removed by the acidity developed in the collodion. In that case, it is fit to be used without additions of iodine or hydrobomic acid.

Ether which is exposed to light, and to the contact of air, will enter into decomposition, and become acid. In this state, it is unfit for photographic purposes. It is necessary for its preservation to put it into well corked bottles, and to keep it in a dark place.

Alcohol.—It is necessary to use the purest alcohol; at least of 92 per cent., or stronger, if possible, and to have it free from essential oil. Sometimes being kept in barrels, or badly corked bottles, it will generate acetic acid. This can easily be detected in testing it with litmus paper. The essential oil is detected by the smell. The quantity of essential oil contained in alcohol made of corn (the one used in this country), is larger than in the spirits of wine, and is peculiarly objectionable.

This oil gives to alcohol a smell known as *whisky smell.* It should be as free as possible of this oil. Unslacked lime will bring common alcohol to a standard suitable for photographic purposes. It should be used in the same proportion, and in the same way, as for the purification of the ether.

Gun Cotton, or Pyroxyline.—There exist three kinds of pyroxyline. One, that is very explosive, and insoluble in a mixture of alcohol and ether; another, that is less explosive, and is soluble in the above named

mixture; and a third, which is partly soluble, and burns without exploding.

The first of these explodes without leaving any residue, and is the only article fit to be used in fire-arms. The second one explodes with less force, and leaves a slight residuum of black ashes. It is unfit for projectile purposes, and is the only one that can be used in photography. The third one burns, leaving an amount of black ashes, and gives a solution in alcohol and ether, which is unfit for photographic purposes.

Gun cotton has the same appearance and physical properties as ordinary cotton, except that it is somewhat more rough in touching, and in pulling it apart through the fingers, it grates.

Although the manufacture of gun cotton is attended with some trouble, we give in the fourth part of this work the easiest, most reliable and certain process to prepare it.

Gun cotton, exposed to air and humidity, very soon becomes acid. This acidity can be detected very easily by the smell, or by dissolving a small quantity in ether and alcohol, and testing the solution with litmus paper. If the litmus is not reddened after one day, the cotton can be used without inconvenience. If acidity is detected, wet it slightly with alcohol, wash it several times in clean water, press the water out in a towel, then let it dry. If you wish it to dry quick, you can wash the remaining water out with alcohol, and then press the alcohol out.

The acidity of the gun cotton is very objectionable, because the acid decomposes the iodides and bromides, setting iodine and bromine free, and giving a red color to the collodion.

The gun cotton of the trade is most of the time acid, because it is in immediate contact with air and moisture, being sold in paper boxes.

If it is kept in tightly corked bottles, it will be as good after six months, as the first day after being made. This acidity, however, being very easily removed, is not a matter of great consequence. For further particulars, we refer the reader to the Chemistry of Pyroxyline.

Having thus the three constituent compounds of the plain collodion, mix them in the following proportions:

Ether	5 fluid ounces.
Alcohol	3 " "

Pyroxyline, 4 to 6 grs. to the oz.; 32 to 48 grs.

This is for moderate temperature. In the hot summer days this collodion may dry too quickly, and in such case, it would be well to increase the quantity of alcohol. The following formula can then be used:

Ether	4½ fluid ounces.
Alcohol	3½ " "
Pyroxyline	32 to 48 grains.

In the cold winter days, on the contrary, when obliged to work out of doors, it will be necessary to increase the quantity of ether, so as to use

Ether	5½ fluid ounces.
Alcohol	3½ " "
Pyroxyline	32 to 48 grains.

The first formula may, however, be used all the year round, by those having their rooms well ventilated in summer, and well warmed in winter. Photographic chemists, who make a large quantity of plain collodion at a time, will do well, in order to keep it from becoming acid, to use alcohol and ether that has been rendered slightly alkaline by the addition of a few grains of lime. In such case, use only the clear part of these liquids, and be careful not to have any lime enter the plain collodion.

It must be observed, when the iodized collodion, made with this alkaline plain collodion, does not take an orange or yellow color, (as remarked above, when speaking of the sulphuric ether,) to add to it a few drops tincture of iodine, or hydrobromic acid. This addition is to be always recommended, when iodide or bromide of cadmium only, has been used in sensitizing collodion.

The proportion of gun cotton to be used in the collodion is variable. Four grains of a certain cotton to the ounce of the mixture of ether and alcohol, may give a collodion a great deal thicker than four grains of another cotton. This difference is owing to the quality of the gun cotton. Two varieties of gun cotton No. 2 exist. The one will give a fluid solution, that flows readily on the plate and gives an even film, and is strongly adherent. The other gives a thick and glutinous solution, that flows with difficulty, gives a wavy film, and easily comes off of the plate. (See Chemistry of Pyroxyline.)

The former solution is the only one that is good for use.

In using a small amount of the second variety, and adding one-tenth of chloroform to the collodion, the evil is lessened to a certain extent; however, it never gives as good an article as the first variety. Most of the gun cottons produce solutions possessing intermediate qualities. These must be rejected, or can be used according to their predominant qualities.

As a general thing, in using cotton that gives a fluid solution, four grains to the ounce is the best proportion. Three grains to the ounce may be used, when it possesses, to a certain extent, the properties of the second variety.

A mixture of ether and alcohol dissolves the pyroxyline. Neither of these liquids, if pure, will dissolve it, when employed alone. Common ether, owing to the alcohol it contains, will dissolve it. The resulting solutions differ somewhat in character, according to the relative proportions of the solvents employed.

When the ether is used in large proportions, the collodion film spreads with difficulty over the plate, owing to the rapid evaporation, the film is very tough and coherent, so that it is difficult to rub off. It is also very contractile, so that the film will often separate from the sides of the plate, if not handled and dried with precaution. When, to such a collodion, alcohol is added in proper proportion, all the inconveniences are removed, and it will spread with more regularity, and give an even, softer and easily-torn film, which possesses great adherence to the plate, has no

tendency to contract, and separate from it in drying. It is then in the most favorable state for working.

When alcohol is added in excess, more than half for instance, the collodion becomes thick and glutinous, because the cotton is less soluble in such a mixture. Then the evaporation is too slow, and the film is too soft, and not sufficiently coherent and tenacious.

Water is introduced into the collodion in connection with the alcohol and ether. An excess of water in the collodion is very injurious. It thickens it and makes it flow with difficulty. The film from this cause is sometimes so rotten, that a gentle stream of water washes it off the plate, and instead of being transparent, it is opalescent. The water is also the cause of the reticulated appearance which the film presents when dry. It seems to be cracked all over, and made up of a kind of network, which deprives the impression of sharpness.

Such effects are more to be feared in cold than in warm weather; so that in winter more care has to be taken to procure a good sample of ether and alcohol, than at other seasons of the year.

In using ether, specific gravity 720, and alcohol, specific gravity 825, this effect will never occur.

Sometimes a sample of gun cotton is used that does not dissolve entirely. In this case it is necessary to increase the quantity of gun cotton, in order to have the proper amount of solution.

Most of the gun cotton made is not entirely soluble. Allow it to settle, and pour the clear part into another bottle, and keep for use.

Gun cotton of which more than half is insoluble, gives ordinarily a bad collodion, yielding an opalescent film, and should be rejected.

Collodion prepared in all the conditions recommended above, will, in being properly poured on a clean glass, present the following peculiarities. 1st, It will not run off the edges of the glass. If so, the quantity of gun cotton is too small. 2nd, It will give, when dry, a transparent film. If the film is semi-opaque, it indicates either that the gun cotton is of bad quality, or that the collodion contains an excess of water. 3d, It will flow evenly, giving a film without waves. If not, the gun cotton is of a glutinous variety, or its quantity too large. 4th, It must be adherent to the glass, and be so tough as to bear a slight rubbing when it has set.

The salts most generally employed to sensitize collodion, are the iodide and bromide of potassium, the iodide and bromide of ammonium, and the iodide and bromide of Cadmium. It has been remarked that the bromides are used in the collodion because the bromide of silver is acted upon with more intensity than is the iodide, by the green, red and yellow rays. The peculiarities presented by each of the above named salts, when dissolved in the collodion, have been spoken of in the second chapter.

Three of these salts are readily soluble in the plain collodion; the iodide of ammonium, and the iodide and bromide of cadmium. The iodide and bromide of potassium, and the bromide of ammonium are, on the contrary, almost insoluble in plain collodion made with

concentrated ether and alcohol. When used, these last three salts are dissolved in the smallest quantity of water possible, and added to the collodion. The iodide of potassium is of the three, the most soluble without water, but not soluble enough to give with ether, sp. gr. 720, and alcohol, sp. gr. 825, a collodion highly enough iodized.

Hydrobromic Acid.—Two or three drops of hydrobromic acid, added to one ounce of iodized collodion, is claimed as being a valuable improvement. It is observed that it gives more brilliancy to the whites, and more beautiful blacks, and when a pale collodion is used, increases slightly its sensitiveness. The tendency to fogging is also diminished in the developing, by the use of this acid in the collodion.

This hydrobromic acid seems to act in producing in the collodion a state analogous to the first stage of decomposition, which is so favorable to sensitiveness, and of which we have spoken in the second chapter. This compound, known by the name of Hydrobromic Acid, is a mixture of hydrobromic acid, bromal, hydrobromic ether, etc. It is prepared in the following manner:

Take 4 parts alcohol, 95 per cent., 1 part water, and add a quantity of bromine sufficient to give it a red color. After twenty-four hours it will become colorless; then add again a certain quantity of bromine, and if it become colorless, the next day add bromine again, and continue so adding bromine every day until it remains yellow. This is a sign that all the alcohol has been transformed. That which remains to be done, is to

remove the color by adding a few more drops of alcohol.

The hydrobromic acid gives to the collodion a deep orange or red color. It is best only to add hydrobromic acid to a small quantity of collodion at a time, because it loses its sensitiveness after one or two weeks, and tends to make the collodion rotten. It can be added to the small quantity required for daily use.

Bromo-Iodide of Silver.—To prepare bromo-iodide of silver, dissolve 120 grains nitrate of silver in 2 ounces of water, and 80 grains bromide of potassium in 2 other ounces of water. In mixing these two solutions together they will decompose each other, and bromide of silver will be precipitated. Wash this precipitate in several waters, and finally in alcohol; letting it settle after each washing, and pouring off the liquid. Then add 1 ounce of iodide of potassium, reduced into very fine powder, and 8 ounces of alcohol (90 per cent.), and shake well from time to time, until the alcohol has dissolved as much iodide of potassium as possible. The clear liquid is a solution of bromo-iodide of silver.

When bromide of silver is dissolved in a solution of iodide of potassium, double decomposition takes place between the bromide of silver and a part of the iodide of potassium, so that bromide of potassium and iodide of silver are formed. The so-called bromo-iodide of silver is, therefore, an alcoholic solution of iodide and bromide of potassium, saturated with iodide of silver.

It must be observed, that the more water the alcohol contains the stronger the solution will be; so that, if

prepared with 95 per cent. alcohol (containing 5 per cent water), it will require a larger quantity to iodize collodion than when prepared with 90 per cent. (containing 10 per cent. water). It will thus be best to use 90 per cent. alcohol, or if stronger, to have it diluted with the required quantity of water.

The bromo-iodide of silver must be made by the light of a candle, and kept in a dark place.

Alcoholic Solution of Iodide and Bromide of Potassium.—To 8 ounces 95 per cent. alcohol put 1 ounce finely pulverized iodide of potassium and 2 drachms bromide of potassium, and shake until the alcohol has dissolved of these two salts to saturation.

We will now give the formulæ of several collodions, accompanying them with the necessary explanations. The operator will do well, before he makes his collodion, to read in the fourth part of this book the chemistry of the different iodides and bromides used in sensitizing.

A.—Plain collodion ..... 8 fluid ounces.
Iodide of ammonium ..... 32 grains.
Bromide of cadmium ..... 24 "

Dissolve, directly, the iodide of ammonium and the bromide of cadmium in the plain collodion, and allow it to settle. The next day it is fit for use. When pure materials have been used, this collodion will be of a yellow color the day after it has been made, and it will keep for a long time. It may be worked with a neutral or with an acid 40 grain silver bath. Any of the given developing solutions may be used with it. It is very sensitive. We recommend this collodion to beginners.

B.—Plain collodion ..... 8 fluid ounces.
Iodide of potassium ..... 32 grains.
Bromide of cadmium ..... 24 "

Put the iodide of potassium in an 8 ounce bottle, and dissolve it in as small a quantity of water as possible; then add the 8 ounces of collodion, and finally the bromide of cadmium.

This collodion keeps very well, but it is a little less sensitive than A. It will work best with a 40 grain acid silver bath.

C.—Plain collodion ..... 10 fluid ounces.
Iodide of cadmium ..... 30 grains.
Bromide of cadmium ..... 6 "

Dissolve directly the iodide and bromide in the collodion, and use the following day.

This is the long-keeping collodion. If the materials used are pure, and it is not exposed to the light, it will keep more than a year. It is best two or three weeks after its preparation. The quantity of iodizing being small, it has to be worked with a weaker silver bath. One of 30 grains to the ounce, containining 1 drop of nitric acid for each 8 ounces, will do very well. If the alkaline plain collodion is used, it will be necessary to add to it a few drops of tincture of iodine or hydrobromic acid.

D.—Plain collodion ..... 8 fluid ounces.
Iodide of potassium ..... 32 grains.
Bromide of potassium ..... 12 "

Dissolve the iodide and bromide of potassium together in the smallest quantity of water possible, add the

collodion, and let it settle. Work with a 30 grain silver bath slightly acid. It will keep for four or five weeks.

E.—Plain collodion, ... 8 fluid ounces.
Iodide of potassium, ... 20 grains.
Iodide of cadmium, ... 20 "
Bromide of ammonium, ... 24 "

Dissolve the iodide of potassium and the bromide of ammonium in the smallest quantity of water possible, then add the collodion, and finally the iodide of cadmium. Work with a 40 grain silver bath, containing one drop of nitric acid to every four ounces. It will keep for months.

F.—Plain collodion, ... 6 fluid ounces.
Iodide of cadmium, ... 15 grains.
Bromide of ammonium, ... 14 "
Bromide of potassium, ... 7 "

Dissolve the two bromides together, in a small quantity of water, then add the collodion, and finally the iodide of cadmium. Same observations as for **E.**

G.—Collodion, ... 8 fluid ounces.
Solution of bromo-iodide of silver, 3 drachms.
Hydrobromic acid, ... ½ "

It will not keep longer than one or two weeks. Use a 30 grain neutral silver bath.

H.—Ether, ... 5 ounces.
Gun cotton, ... 32 grains.
Alcoholic solution of iodide and bromide of potassium, ... 3 ounces.

This will keep for about a month. Use with 30 grain silver bath, neutral or slightly acid.

We have given here the formulæ of the collodion most generally used. We could, if necessary, give many others. Any combination of the three iodides, and the three bromides, above named, will give good results, if there exists a relation between the quantity of iodizing, the quantity of cotton, and the strength of the silver bath.

The stronger the iodizing, the stronger the bath must be, and a larger quantity of gun cotton must be used, in order to retain on the plate the iodide and bromide of silver formed in the silver bath.

The rules to be observed in regard to that relation are these. If the film of the collodio-iodide of silver, formed in the bath, is transparent and blueish, use a 20 grain neutral or very slightly acid silver bath. If the film is less transparent, and gray, use a 30 grain silver bath, pretty acid.

If it is white, and semi-opaque, without being creamy, use a 40 grain acid silver bath. If creamy, use a 50 grain acid nitrate bath.

The use of hydrobromic acid in the collodion, or of nitric acid in the bath, must be avoided with transparent films, and with weak silver baths, because it is very injurious to half tones. The quantity of nitric acid given in the above formulæ is always the minimum. We will see, in the practical details, in what cases it is desirable to increase its quantity.

Our experience teaches us that the best results are obtained with the most facility, by using white and semi-opaque films, with a 35 or 40 grain acid silver

bath. If one of the collodions prepared by the above formulæ, gives a creamy film, or one that is too transparent, bring it to that state of iodizing which is white, or semi-opaque —The opacity of the collodion film depending, 1st, on the quantity of iodizing; 2d, on the quality of cotton, giving a more or less fluid solution, it can be increased or decreased, in two different ways. 1st, By increasing, or decreasing the quantity of iodizing; 2d, By increasing or decreasing the quantity of cotton.

Thus, when the film is transparent, then add cotton to give it more opacity. When transparent, and of the required thickness, add iodizing.

When it is opaque and thin, dilute with plain collodion. When opaque and thick, dilute with alcohol and ether, in the proper proportions.

We have already seen, that after some time a spontaneous decomposition takes place in the collodion, by which iodine is set free, so that from white or yellow it becomes an orange, and then a red color.

We have seen, also, that the first stage of the decomposition is favorable, and that hydrobromic acid produces it artificially; but that, finally, the gun cotton is decomposed, and that the collodion becomes so acid that all its sensitiveness is lost.

When this commences to take place in a small quantity of collodion, it is not objectionable, because it can be used up before it loses entirely its qualities. But when a large quantity is on hand, it is necessary to prevent the decomposition, and this is easily done by

putting a small strip of zinc in the collodion when it commences darkening in color.

The zinc will prevent the decomposition and render the collodion colorless. In that state it will keep for months.

It is necessary that the sub-oxide which covers the zinc, should be removed by immersing it, for a few seconds, in dilute nitric or sulphuric acid, and then washed.

On different Compounds, used as Accelerators in the Collodion.—Several substances, when mixed in the collodion, in certain proportions, and in certain circumstances, reduce the time of exposure in the camera. Such are the iodide of iron, oil of cloves, benzole, etc.

Iodide of Iron.—For photographic use this substance is prepared by dissolving 2 drachms of iodine in 1 ounce of alcohol, then adding 1 ounce of water, and 1 ounce of iron filings or thin wire. After about twenty-four hours the iodine will be combined with the iron, and a green solution obtained.

The accelerative properties of the iodide of iron are more sensible with brown than with colorless or yellow collodion. Ten drops added to one ounce of the former will reduce the sitting time more than half; while added to one ounce of the latter, it will only increase the sensitiveness one-sixth.

Oil of cloves, and benzole, are only accelerators to brown collodion. They seem to produce no effect in collodion which is not undergoing decomposition.

Collodion mixed with such accelerators will not keep, and very small quantities should be so prepared at a time.

CHAPTER IV.

THE SILVER BATH.

THE materials which enter into the silver bath are the following: — Crystalized nitrate of silver, water, iodide of potassium, and nitric acid.

Crystalized Nitrate of Silver.—The salt which is sold by druggists and by photographic stock dealers is pure enough for photographic purposes.

The fused nitrate of silver is very often adulterated with nitrate of potash, so that its use is not recommended. When a quantity of crystalized nitrate of silver is dissolved in the smallest possible quantity of distilled water, long slender needles will be observed on the ground of the bottle. These needles are *nitrite of silver*, and are only soluble in 120 parts of water.

Nitrite of silver is an accelerator, but can only be used for negatives, because it gives to positives a grey and displeasing tone. A small quantity of nitric acid transforms it into *nitrate of silver.*

Water.—The water required to dissolve the nitrate of silver must be pure, free from organic matter, and from salts. Distilled water will answer the best, or rain

water that has been caught in an open jar, and filtered through charcoal.

Rain water that comes from roofs, must be rejected on account of the large quantity of organic matter it contains. Soft spring water, filtered through charcoal, may be used when no other can be obtained.

Iodide of Potassium, and Bromide of Potassium.—Such as are used in iodizing collodion answer for the bath.

Nitric Acid.—The ordinary will answer, but it is better to use the chemically pure.

The strength of the silver bath generally made, is from 20 to 40 grains to the ounce. This depends on the quantity of iodide and bromide contained in the collodion.

A 20 grain bath has to be used with a slightly iodized collodion, such as gives a blue, transparent film, when dipped into the silver bath. We do not recommend the use of such a combination, although it may give as good a picture as when larger proportions are used. The use of collodion, slightly iodized, with such a bath, is more difficult, especially in the developement of the impression.

Neutral Bath, 40 grains to the ounce.—

Water, ... 30 fluid ounces.
Nitrate of silver, .. 40 grains to ounce, 1,200 grains.
Iodide of potassium, ½ " to 100 grs. of silver, 6 "
Bromide " ¼ " " " 3 "
Nitric acid, ... 1 or 2 drops.

Dissolve the nitrate of silver in 10 ounces of water, and the iodide and bromide of potassium in 10 other ounces of water, and mix the two solutions together. A precipitate of iodide and bromide of silver will be formed, of which a part will be dissolved. Then add the 10 other ounces of water, and the nitric acid, let settle, and filter the clear part through paper or cotton, into the gutta percha or glass bath.

A solution of nitrate of silver dissolves iodide and bromide of silver, to a certain extent. It is therefore necessary, previously, to saturate the nitrate bath with these two salts.

If no attention is paid to this, the iodide and bromide of silver, after having been produced, would be attacked and partially dissolved. This is the reason why iodide and bromide of potassium must be added, which by double decomposition change into the iodide and bromide of silver.

The nitric acid is added to the silver bath in order to transform the *nitrite of silver* into *nitrate.* Add one drop at a time, thoroughly mix, allow it to settle a short time, and test with blue litmus paper. When the litmus paper becomes slightly red, after an immersion of five minutes, it is a proof that all the nitrite has been transformed into the nitrate, and that the bath is very slightly acid. It may be used in that state, and considered neutral; or the small quantity of acid may be removed by adding one or two drops of a solution of 60 grains carbonate of soda, dissolved in one ounce of water.

Acid Bath, 40 grains to the ounce.—Prepare it the

same way as the previous, but add from 5 to 15 drops nitric acid, and use in that state.

Neutral Bath, 30 grains to the ounce.—

Water,	30 fluid ounces.
Nitrate of silver,	900 grains.
Iodide of potassium,	4½ "
Bromide "	2 "
Nitric acid,	1 or 2 drops.

Prepare this the same way as the 40 grain neutral bath.

Acid Bath, 30 grains to the ounce.—This bath is prepared as the foregoing, with the exception, that from 5 to 10 drops nitric acid are used, and the acidity is not neutralized by carbonate of soda.

It is recommended to filter the silver solution through Swedish filtering paper, or, better yet, through cotton. Put a tuft of cotton into the neck of a funnel, pour on 10 or 12 drops of alcohol, remove the alcohol with water, and then pour your silver solution into the funnel. It may, at first, not filter entirely clear, but it will soon become so.

Before filtering the silver solution, it is necessary to let it settle; if not, the iodide and bromide of silver would soon obstruct the filter.

The cotton is firstly saturated with alcohol to allow the liquid to pass through more readily.

Decomposition in the Bath by the influence of Light.—Pure solution of nitrate of silver is not affected by light; but when it contains organic matter, the nitrate of silver undergoes a decomposition under its influence, and a

black deposit is produced. It is therefore necessary that a nitrate solution, which has been worked, and consequently contains alcohol and ether, should not be exposed to light, and this is specially to be observed when the bath is neutral.

The effect of the decomposition is a tendency to fogging in developing, which can only be removed by the addition of nitric acid.

Neutral and Acid Baths.—Neutral baths are those which contain neither free acids nor free oxides. They do not turn red the blue litmus paper, as do the acid baths; nor do they turn blue the reddened litmus paper, as do the alkaline bath.

Neutral silver baths are recommended by many as giving better pictures than acid ones.

We have not in our experience met with such success as would corroborate this statement. We have always been more successful with an acid bath, than with a neutral one, when making positive pictures.

It is true that the sitting time is a little longer with the acid than with the neutral bath, but this disadvantage is amply compensated by the greater facility in developing, and a greater uniformity in the working state of the bath. We would recommend to use always the 30 or 40 grain acid silver bath as described above, except with collodion, such as G, which is very acid.

In using a 20 grain bath, nevertheless, with slightly iodized collodion, it is necessary that any free nitric acid in the bath should be removed. For this correction, drop into the bath a few drops at a time of a solution of 60

grains carbonate of soda to one ounce of water, until a distinct turbidity of the bath is produced, which is not removed by agitation. Then filter and add 2 or 3 drops acetic acid.

Every time a plate coated with collodion is dipped into the bath, a portion of nitrate of silver is transformed into iodide and bromide of silver, and a portion of the silver solution is taken out; so that while the silver solution decreases in volume, it also decreases in strength. It will, therefore, be necessary to fill up the bath every day with a solution that contains a quantity of nitrate of silver sufficient to restore the bath to its original strength. But that quantity of nitrate of silver depends altogether on the quantity of iodide and bromide contained in the collodion film, and is difficult to determine. As a general thing, it will answer to fill up a bath containing 40 grains to the ounce with the following solution:

Water, ... 8 fluid ounces.
Nitrate of silver, ... 1 ounce.

To fill up a 30 grain bath, use

Water, ... 10 fluid ounces.
Nitrate of silver, ... 1 ounce.

It is recommended to add every night to the silver bath a quantity of one of the above named solutions, corresponding in volume to the quantity that has been taken out. If you wait until you have to add a large quantity at a time, the condition of your bath will change too much, and it may give you some trouble.

We have not added to the solution used in filling up

the bath, any iodide or bromide of potassium, nor any nitric acid. The quantity of nitrate of silver added every day is too small to dissolve sensibly the collodion film, so that the iodide and bromide are useless in making the addition.

In regard to the omission of the nitric acid, we observe that every plate coated with yellow or red collodion imparts acid to the bath, so that the acidity always increases, and even would increase to an excess, if a certain quantity was not used to transform into nitrate of silver the small quantity of nitrite of silver contained in the above named solution.

When the operator has some uncertainty in regard to the strength of the silver bath, there is an easy way to estimate it with sufficient accuracy.

Take the pure crystalized chloride of sodium, and fuse it at a moderate heat, in order to drive away its water of interposition ; then dissolve 17 grains of it in 12 fluid ounces distilled water. Each drachm of this standard solution will precipitate half a grain nitrate of silver. Now take one fluid ounce of the silver bath, and commence adding a few drachms of the standard solution at a time, shaking after each addition, and letting the precipitate settle. A few drops of pure nitric acid added to the silver solution will facilitate the deposition of the precipitate. When no more precipitate or milkiness is produced by a fresh addition of the standard solution, it is a proof that all the nitrate of silver has been precipitated. Now divide the number of drachms used by 2; the quotient will be the number of grains

of nitrate of silver contained in one ounce of your silver solution.

Suppose we have to determine the strength of a bath that was originally 40 grains to the ounce, but that by being worked is not supposed to contain more than 30 grains; we will commence adding to one ounce of the solution at first 20 drachms; then, after the precipitate is settled, we will add 20 drachms more, then 5 drachms, again 3 drachms, 1 drachm, and so continue until no more precipitate is produced.

If we have used 58 drachms of the standard solution, we will know by it that the bath contains 58 half grains, or 29 grains nitrate of silver to the ounce of water.

The testing of a silver bath, or of any other solution, can be done by means of an instrument called *Actino hydrometer.*

In the formulæ of silver baths given above, we have only indicated the minimum of nitric acid to be added. It will be seen in the sequel in what cases it is advisable to increase the quantity of acid.

CHAPTER V.

DEVELOPING SOLUTION.

THE materials used in the developing solution are the following:

Protosulphate of iron.	Water.
Acetic acid, No. 8.	Nitric acid.
Alcohol.	Nitrate of potash.
Nitrate of silver.	

Protosulphate of Iron.—This salt is known in the trade by the names of copperas or green vitriol. Common sulphate of iron requires re-crystalizing, in order to render it sufficiently pure for photographic purposes.

Water.—Distilled water, filtered rain, spring, and river water can be used. It does not require to be as pure as for the silver solution; the impurities being mostly precipitated in an insoluble state by the protosulphate of iron.

Acetic Acid, No. 8.—This acetic acid as found in drug-stores is sufficiently pure.

Nitric Acid.—It is best to use the chemically pure.

Alcohol.—Ordinary alcohol will answer.

Nitrate of Silver.—Use the ordinary crystalized.

Nitrate of Potash.—Known in the trade by the name of nitre. Use the refined nitre.

We will give several formulæ for developing solutions. Among these, the A, B, and C give dead whites. The D and E give metallic whites; F gives something between the two:

A.—Water, ... 32 fluid ounces.
Protosulphate of iron, ... 2½ ounces.
Acetic acid, No. 8, ... 3½ "
Alcohol, ... 3 "

This is the solution we generally use.

B.—Water, ... 40 fluid ounces.
Protosulphate of iron, ... 3 "
Acetic acid, No. 8, ... 4 "
Alcohol, ... 3 "

C.—Water, ... 10 fluid ounces.
Protosulphate of iron, ... 1 "
Acetic acid, ... 1 "
Alcohol, ... 1 "
Nitrate of silver, ... 20 grains.
Nitrate of potash, ... 120 "

D.—Water, ... 12 fluid ounces.
Protosulphate of iron, ... ½ ounce.
Acetic acid, No. 8, ... 1 " fluid.
Nitric acid, ... 2 drachms fluid.
Nitrate of silver, ... 20 grains.
Nitrate of potash, ... 150 "

E.—Water, ... 48 fluid ounces.
Protosulphate of iron, ... 2 ounces.
Nitric acid, ... 1 drachm.
Acetic acid, ... 2 "

F.—Water, ... 32 ounces fluid.
Protosulphate of iron, ... 2½ "
Acetic acid, ... 1½ "
Alcohol, ... 2½ "
Sulphuric acid, ... 70 drops.

Add the nitric acid when all the protosulphate of iron has been dissolved.

The last three solutions may be used only with a bath as strong as 40 grains to the ounce. If used with a weaker bath, the exposure to light is too long, and the development is irregular.

The effect of the alcohol and acetic acid is to render the development uniform, by causing the protosulphate

of iron to flow more evenly on the plate. The acetic acid has also the effect to whiten the image, when used in proper proportions. The nitric and sulphuric acids make the whites metallic, but when too much is employed it develops irregularly.

The nitrate of potash added to the developing solution improves the color slightly.

Before using the developing solution, let it become two or three days old. It commences then to take a reddish color (if it does not contain nitric or sulphuric acid), and in that state works better and more evenly.

The more acid of any kind which a developing solution contains, in proportion to the quantity of nitrate of silver contained in the bath, the longer must be the exposure in the camera, and the greater the contrast will be between the light and dark parts.

The relative proportions of ingredients used in the developing solution may be changed according to the effect which is desired.

If using, for instance, the developing solution A, we wish to obtain a greater contrast between lights and drapery, we will have to increase the quantity of acetic acid. If the contrast is too great, decrease it.

If the developer does not flow evenly, add more alcohol.

The developer, before using it, should be filtered through Swedish paper, or through cotton, the same way as the silver solution.

CHAPTER VI.

THE FIXING SOLUTION.

THE materials used as a fixing agent, are the cyanide of potassium and the hyposulphite of soda.

The fused cyanide of potassium as found in drug-stores, although very impure, is suitable.

One drachm of this cyanide of potassium dissolved in 8 ounces of water, will answer.

If hyposulphite of soda is used, 2 ounces should be dissolved in about 8 ounces of water. The cyanide of potassium is generally preferred, because its use is less expensive, and it is removed by washing with greater facility than the hyposulphite of soda. The operator must be cautious in using cyanide of potassium, it being a poison. Its contact with wounds or sores on the hands should be avoided. It will remove the stains of nitrate of silver, but should itself be well washed from the skin.

PRACTICAL DETAILS.

CHAPTER VII.

CLEANING THE PLATE.

WE have seen, in the first chapter, that the surfaces chiefly used for the production of positive pictures, are the glass and the melainotype plate.

In the choice of the glass much care should be taken.

It should be white, perfectly flat, without scratches, and free from scoria and air bubbles.

Before proceeding to clean the glass, the sharp edges should be filed off, to prevent cutting the fingers, and also to prevent the collodion film from separating from its sides. If the glass has been handled, it will be necessary to wash it with a solution of caustic potash, 1 part potash to 10 parts water, in order to remove the grease. This solution, softening and corroding the skin, should be applied with a flannel rag fixed on a small stick, then allowing the glass to stand for a few minutes, it should be well washed with clean water, and dried with a towel that is not used for other purposes.

If the glass has not been handled, this first operation may be dispensed with.

Prepare, now, a mixture of rotten-stone, water, and alcohol, to which you add a few drops of nitric acid, and rub the glass for some moments with this mixture, using for the purpose a piece of Canton flannel. Then, before it is dry, rub quickly with another piece of flannel, and finally finish gently with a clean piece of buckskin. If the glass is clean it will be indicated by a uniform condensation of the moisture when breathed on.

A mixture of rotten-stone, water, and a few drops of nitric acid, will also answer very well in cleaning.

The glass has in this way to be cleaned on both sides, and the edges have to be wiped with a piece of flannel. While cleaning the glass it should be held in a wooden vise or plateholder. The vise used by Daguerreotypists

to hold Peck's patent plateholders, will answer the purpose.

When the glass has received an impression, it should, before being cleaned with diluted alcohol and rotten-stone, be put into water, acidulated with one-fifth of nitric acid, then washed.

When varnished they will have to be immersed in this acidulated water for half a day, or be rubbed with the solution of caustic potash.

If soiled with balsam of fir, they must be cleaned, firstly with alcohol, then the caustic potash will have to be applied, and the cleaning then continued as above.

The melainotype plates are less troublesome than glass. When new they do not want any cleaning; simply brushing off with a blender, to remove any particles of dust, is all that is required, unless the plate has been handled and touched on the surface, with the fingers. In this case, put a few drops of alcohol on the spot, and rub off with a piece of flannel. No rotten-stone, or scouring material is required, as the surface of the plate will not bear this. But very light pressure is needed in cleaning.

If an unsatisfactory picture has been made on the plate, rub it off when it is yet wet, wash with clean water, and wipe with a silk handkerchief. It is then ready for use. If the picture is dry, rub it off with a little alcohol, and then go through with the aforesaid process of washing and wiping.

When the plate has been varnished, the varnish must be dissolved with alcohol and ether, using several

pieces of clean flannel; finally, it has to be washed with water, and wiped dry with clean, soft cotton flannel, or silk.

Care has to be taken not to scratch the melainotype plate in cleaning it. It should be well understood that the melainotype plates do not want polishing. The object in cleaning them is only to remove foreign matter.

The leather, oilcloth, and mica, are cleaned with as much facility as the melainotype plates. When new they require only dusting off.

CHAPTER VIII.

FORMATION OF THE FILM OF COLLODIO-IODIDE OF SILVER.

HAVING cleaned the glass, the next operation is coating it with collodion. This part of the manipulation should never be done too hurriedly. Grasp the plate firmly between the thumb and fore-finger, holding it at the lower left hand corner; hold it as nearly level as possible, and after having dusted it off with a blender, commence by pouring the collodion on at the corner by which it is held, inclining the plate down, so as to cause the collodion to flow toward the upper left hand corner, from thence toward the right side, and then down to the lower right hand corner, allowing the drippings to pass back into the bottle. It is best, now, to hold the plate perpendicular, moving it slowly back and

forth, which will cause the collodion to flow together in one smooth surface. Should you neglect this, you will invariably have lines running diagonally across the plate.

If such lines should be formed, notwithstanding that proper care had been taken to avoid them, the collodion is too thick, and should be diluted with alcohol and ether, in the proper proportions.

The bottle that contains the collodion should be wiped at the mouth before flowing each plate, as small particles of dried collodion, hanging at the edge of the bottle, will often be loosened in pouring from it, and becoming mixed with the film will cause a spot on the picture.

The next operation is immersing in the nitrate of silver bath.

The baths ordinarily used are made of gutta percha, and of a peculiar construction. They are styled overflowing baths, and may be had of most dealers in ambrotype materials. If they could be obtained of glass or porcelain, they would be preferable. They are accompanied with a dipper of glass, or gutta percha.

Before putting the plate into the silver bath, allow the collodion film to *set*. This is easily determined by touching the finger to the edge of the plate where it was poured off, and when it does not stick to the finger it is ready for immersion. The time required by the collodion to *set*, depends, 1st, On the relative proportions of ether and alcohol used; 2d, On the temperature of the atmosphere; and 3d, On the thickness of the collodion. Place the plate on the dipper carefully, and lower it gradually into the bath, not *too fast*, nor *too slow*. Any check

of the plate, while being put into the bath, will cause horizontal lines across the surface.

The plate must be left in the bath a time sufficiently long to allow all the iodide and bromide contained in the collodion film to be transformed into iodide and bromide of silver. If taken out as soon as the greasy appearance, caused by the evaporation of the alcohol and ether, is gone, as such is recommended by some operators, and used in this state, it will be observed that when it is removed from the tablet to be developed, it presents a great deal more opacity than before it was put into the plate-holder. This is a conclusive proof that all the iodide and bromide was not transformed into iodide and bromide of silver during its immersion in the bath, and that the transformation was yet going on when the plate was removed out of it, at the expense of the nitrate of silver that was on the surface of the film. This nitrate of silver on the film is necessary, and required in the process of developing the impression; so that removing a plate out of the silver bath too soon, is weakening the nitrate of silver on the surface of the plate, and is the same as using a bath that is too weak; in such a case the necessary relation between collodion and the silver bath does not exist—and a satisfactory result can not be expected.

It is sometimes the case that curved lines are produced on the part of the plate where the collodion is poured off. This occurs when it is dipped into the bath before the collodion has had sufficient time to set; they are more frequent when the collodion contains an excess of alcohol.

The length of time the plate has to remain in the bath depends, 1st, on the quantity of iodizing; 2nd, on the strength of the bath; 3d, on the temperature. Generally, three or four minutes will answer the purpose.

Should the film not adhere to the plate, but, on the contrary, show a disposition to leave it while being put into or taken from the bath, or when washing at the filter, add a small quantity of alcohol to the collodion.

If the plate is removed out of the bath before the greasy appearance has disappeared, oily spots or marks will be perceived on the plate after developing.

The silver bath will become weaker by being worked, and consequently, to a certain extent, will lose its power of dissolving the iodide and bromide, which will, therefore, be precipitated and float as a very fine powder in the bath. If a plate remains in such a bath three or four minutes, this powder will stick on the film and produce a multitude of black spots, which, on application of the fixing solution, will be transformed into as many holes.

The way to avoid this state of the bath is to fill it up every day with a strong solution of nitrate of silver, having neither iodide nor bromide in solution, as has been remarked.

The way to remedy it is, to filter it through two thicknesses of Swedish paper, and add some crystals of nitrate of silver.

Such accidents are very common, and constitute frequently the basis of discouragement to many operators. They filter and filter again their bath, and can not

remove from it what they call dirt and granules of foreign matter—just because every plate they dip weakens their bath, and imparts fresh supplies by precipitating iodide and bromide of silver. So that, while by one mode they endeavor to purify their silver solution, they are, by another process, ignorantly adding innumerable particles.

If the bath is managed as we have recommended, this inconvenience will be entirely avoided. If a bath prepared according to the formulæ given in chapter IV., produces foggy pictures, or pictures with misty drapery, the quantity of nitric acid should be increased a few drops at a time, until the required effect is obtained.

Observe that the change expected by this addition will only fully be produced the next day; so that it is necessary to allow the solution to stand.

This remark holds good with any change effected either in the silver bath or in collodion. The desired change is not entirely effected until after 24 hours.

When the silver bath contains too much nitric acid, the pictures are burned in the high lights, and without presenting any detail in the shadows. It may then be restored by neutralizing a part of the acid, by means of a solution of carbonate of soda, or better, in adding to it 5 to 10 grains of crystalized nitrate of silver to the ounce. In the latter case, the quantity of nitric acid remains about the same, but the bath being stronger can bear it better.

By increasing the quantity of iodizing in the collodion, and decreasing the quantity of acid in the devel-

oper, good pictures may also be obtained with a bath that in ordinary circumstances is too acid.

The silver bath should be kept covered to avoid the dust, and its evaporation. When small particles of dust are discovered on the surface of it, a quantity of solution should be poured into the bath sufficient to cause it to flow over into its smaller portion, from whence it is discharged into a bottle by means of a pipe. This overflowed liquid may be used again after filtering.

The silver solution should always remain excluded from the light. It may be kept constantly in the gutta percha or glass bath; but some prefer pouring it into a bottle every night.

Sometimes the silver bath gets out of order, without it being possible to determine the cause of it. This results most frequently from uncleanliness and carelessness—dipping into the bath plates that are not cleaned on the back side or on the edge; leaving the bath uncovered, so that dust and organic matter floating in the air are deposited in it, producing decomposition; also by exposure to the light; preparing ammoniacal paper in the same dark room where the bath is standing; accidental contact with developing or fixing solutions, etc.

All these may produce the same effect—fogging of the pictures. The bath will, in most of these circumstances be restored by an increase of nitric acid and filtering. The contact of the silver bath or the collodion plate with hyposulphite of soda and protosulphate of iron must be particularly avoided. The operator

should have his hands always very clean, washing them after developing and after fixing.

In order to avoid all interruption of baths getting out of order, we would recommend to every operator, that he should have at least two silver solutions. Sometimes a bath that does not work very well, will improve by reposing two or three days. Very often a bath that has been set aside because it would not work, will after some time give very good results. This is something which most of operators have certainly observed. What is the change that is taking place in such circumstances, we have not been able to ascertain; nor do we know of any photographic chemist who has thrown light on this subject. These facts have suggested the idea, to have always five or six silver solutions ready for use, and when one is discovered to produce poor results, then to take another. Working with such an arrangement, it is generally found that the solution which has reposed the longest works the best.

Collodionizing the melainotype plate and immersing it into the bath, are done with the same facility as the glass plate.

Some objections have been urged that there would be danger of reduction of the silver bath, by the use of the iron plate. This is not so; as we have now in good working order, a silver bath which has been in constant use for seven months, and in two instances has had a one-sixth size iron plate to drop from the tongs, and to remain in the bath, at one time for sixteen hours, and at another for forty-eight hours, and in neither case was there any

perceptible change in the working of the bath. This, then, is sufficient proof that no danger need be apprehended in working the iron plate.

The mica, oil-cloth, patent leather, and ambrograph paper, before being coated with collodion and dipped into the silver bath, have to be fixed firmly and evenly on a glass plate, by wetting one side of it and pressing them on its surface.

We would recommend to be very cautious in the use of the ambrograph paper. A prolonged immersion in the bath will be sufficient to spoil it, if the black varnish is not entirely dry.

The coating of the plate may be done in the light, but the sensitizing and the developing have to be done in the dark room.

The dark room may only be lighted by a small lamp, or by diffused daylight shining through a deep orange-colored pane of glass. Glass stained red, and red muslin, and red tissue-paper, may be employed to transmit light through, but they are not so good as the orange-colored glass.

CHAPTER IX.

EXPOSURE IN THE CAMERA.

After taking the plate from the bath, allow it to drain a few seconds before putting it into the tablet.

The tablets should be occasionally carefully wiped, to prevent a puddling or marbleized appearance at the

bottom of the plate, and also that splashing of the drainings which produces black spots and streaks on the picture. It should be held always in the upright position, in order to prevent the nitrate of silver that has flowed to the lower part of the plate, and come in contact with the wood, from again flowing over the collodion film; which would undoubtedly produce the marbleized appearance spoken of above.

It will be found useful to varnish the inside of the tablet with a solution of gum shellac and alcohol, in order to prevent the staining on the lower part of the plate. The gum shellac should be digested for several hours in concentrated alcohol. This, applied to the tablet at the close of each day, will tend to preserve it from the corrosion of the nitrate solution.

The sitter should always be arranged in the chair, and the focus adjusted with the camera, previous to taking the plate from the silver bath; otherwise the plate would become too dry by standing.

The length of time the coated plate must be exposed in the camera, depends—1st, on the sensitiveness of the collodion film; 2nd, on the strength of the light; 3d, on the length of the focus of the lenses; 4th, on the quantity of acid in the developer; 5th, on unknown atmospheric influences.

A film prepared in a neutral bath is more sensitive than one prepared in an acid bath. The more acid the bath contains, the less sensitive is the film. Between the sensitiveness of a plate prepared in a neutral bath, and the one prepared in a slightly acid bath, such as

we recommend, the difference in sensitiveness is trifling.

By using a collodion slightly iodized, with a 20 grain neutral silver bath, more sensitiveness is obtained than with a tolerable highly iodized collodion and a 40 grain neutral silver bath. The use of neutral baths is, however, not recommended, for the reason of their greater trouble in working.

The melainotype plates, the oil-cloth, the ambrograph paper, and the leather, require about the same sitting time as does the glass.

In the most favorable circumstances, in-doors, by diffused light, and with an ordinary half-size Harrison camera, tolerable highly iodized collodion, used with a 40 grain bath, slightly acid, and the developer A, will work in about three seconds on glass, on melainotype plates and other black surfaces.

CHAPTER X.

DEVELOPING THE PICTURE.

After the plate has been exposed, carry it back into the dark room and develop it. The developing consists in precipitating, in a metallic state, on the parts affected by the light, the silver contained in the iodide and nitrate of silver which is on the plate.

In developing, always hold the plate by one corner,

and start the solution on at the bottom of the side clasped in the hand. Use enough of the solution to flow the plate instantly, as it should be entirely covered before the action commences; otherwise there would be an uneven development. The length of time required to develop will vary, and must be determined by the operator. As soon as the image is entirely visible, throw off the developing solution, and wash the plate immediately with water. It is then ready for the fixing process.

Throughout, some difference will be experienced by beginners in the developing of films on black surfaces; especially those who have used the glass. A few hours use of the plate, however, will perfect in this department.

It may be advisable, at times, to vary the proportions of acetic acid and alcohol in the developer. The alcohol has the effect to cause the solution to flow more evenly and unite with the film. If the protosulphate of iron is in excess, it will be difficult to pour it on the plate sufficiently quick before the action of developing begins. In such a case, after fixing with the cyanide, curved lines will be seen, such as would be produced by a wave of fluid flowing forward and resting for an instant at a particular spot.

If the iron is too weak, the development will be slow, and the picture become slightly gray and metallic on drying. If the acid is too strong in the developer, the reduction is checked and the development is slow; if too weak it is sudden and violent. In the first case it

retards the development, and gives a gray tin-foil hue, and the surface is bright and sparkling like frosted silver; in the second case, the image is dull and without luster, of a white color, inclining, when imperfect, to a yellow or gray, and there is no appearance of metallic luster; it is more like that of chalk.

All acids tend, not only to retard the development, but also to increase the length of exposure in the camera. Nitric and sulphuric acid principally do so; acetic acid acts more feebly. When too much nitric acid is present in the developer, or in the bath, it will prevent the deposition of nitrate of silver in the shades, and thus give a picture without half tones, and presenting too great a contrast between the whites and blacks.

This is principally seen when thin films or weak baths are used. The remedy is to lessen the acid in the developer, or neutralize it in the bath by means of carbonate of soda, or to iodize more highly the collodion and strengthen the silver solution.

Free nitrate of silver is required on the plate during the developing process. If, after its exposure to light, the plate is washed carefully with water, no image will be brought out by the developer. During the exposure of the plate to light in the camera, free nitrate of silver is not required, since a plate washed carefully with water before its exposure, will give an image if it is dipped in the silver bath before developing. In such cases, however, it is necessary to increase the sitting time; for the free nitrate of silver on the surface of the film acts as an accelerator.

The proportion of the nitrate of silver required on the collodion film—or, in other terms, the strength of the bath—depends on the quantity of iodide and bromide contained in the collodion. If the supply of nitrate of silver is too small, the image will be feeble and imperfect; if, on the contrary, it is too large, it will be too intense and lead to fogginess.

CHAPTER XI.

FIXING THE PICTURE.

THE fixing of the picture consists in dissolving in the cyanide of potassium, or in the hyposulphite of soda, the iodide of silver that has not been reduced by the subsequent action of the light and the developer. The fixing, with cyanide, should not be done in the dark room (unless a large one), as it has an injurious effect on the picture in developing.

The fixing solution should never be too strong; on the contrary, it is better to be too weak. Its action will be slower, but the effect will be as good, and there will be no danger of spoiling the picture by dissolving a part of the reduced silver.

As soon as the iodide of silver has been dissolved from the surface, it should again be washed well with water, as any quantity of the cyanide of potassium, no matter how small, will soon cause the picture

to change to a brownish hue. It is best, in this last washing, to use plenty of water. The picture is now ready to dry ; this may be done by means of a gentle heat from a spirit lamp, or it may be set up to dry either in a small oven or by slow evaporation.

CHAPTER XII.

WHITENING OF THE IMAGE.

When the image obtained has not good whites, some operators pour on it, before drying, a saturated solution of bichloride of mercury in water.

The effect of this solution is, firstly, to blacken the picture, and then to bring it to a bluish white. This operation takes about five minutes, but can be shortened by putting the plate on a gilding stand, and warming it gently with a spirit lamp, in the same manner as gilding a daguerreotype plate.

When the image is of a uniform white appearance, pour the remaining solution off, and wash thoroughly with clean water.

Whitening the image by this process is not recommended, as the whites obtained are very seldom perfect, and are most of the time of a bluish disagreeable tint.

CHAPTER XIII.

MOUNTING THE PICTURE.

THE manner of putting up the glass picture is variable. It may be sealed to another glass by means of the balsam of fir. This is the patented ambrotype process of Mr. Cutting. It will do very well for small pictures in cases, but in hanging pictures the air will penetrate between the two glasses and the balsam ooze out; and especially is this the case when exposed to the sun.

The best way to put up the ambrotypes is to varnish them with Anthony's diamond varnish, or with the French diamond varnish, sold in Cincinnati by Peter Smith; then to back it with a glass that has been previously coated with asphaltum varnish, taking care to keep the glasses separated with a paper mat.

Many operators put up the glass picture reversed, showing the collodion side, which is coated with white varnish, and coating the opposite side of the same glass with asphaltum varnish; then covering with a mat and glass, as in the daguerreotype.

Some operators cover the collodion side of the picture, first, with a spirit varnish, and then with the asphaltum varnish. But this throws down the whites, and will in time prove very injurious, by discoloring and cracking.

The pictures on black surfaces can only be put up reversed, like the daguerreotype. They should be

coated with one of the two articles of diamond varnish, and then mounted with mat and glass.

It is recommended to varnish the back of the melainotype, when it is put into the case, with a solution of shellac in alcohol, in order to prevent any oxidation of the iron. Any other varnish may be used. It is best to apply it with a brush to prevent it running on the side where the picture is.

To apply the varnish, pour it on the surface of the plate, and let it run off at one corner like, as is done in flowing with the collodion. To avoid dust settling on the face, hold the plate downward, after having held it in a vertical position for a sufficient time to set.

If the varnish is dirty, filter it through filtering paper, taking care to cover the funnel with a glass plate to prevent evaporation. It is not necessary to use any heat in drying the French diamond varnish, or Anthony's diamond varnish. They both dry rapidly, giving a beautiful surface.

In using an alcoholic varnish, it will be necessary to warm the plate slightly. Some persons object to the two varnishes we recommend, on account of a disagreeable smell. All we have to say in regard to this objection, is, that the smell is not unhealthy, and that they had better habituate themselves to it, than to use an inferior article, which changes in color by age or exposure.

The picture can be colored, before applying the varnish, or after. In applying them upon the varnish the colors look more brilliant, but will not stand. In

showing the right side through the glass plate, the colors will always have to be applied before varnishing, otherwise they would not show through.

The colors best adapted are those commonly used for daguerreotypes, with the exception that it is better to substitute the Indian red for the carmine, to render the flesh color.

Pictures for lockets, breastpins, etc., must be taken on mica, on the melainotype plate, or on some other black surface. The melainotype plate answers this purpose to our satisfaction, the manipulation being easier, and susceptible of being readily cut to any desired size. The picture is also better preserved, than when taken on mica, ambrograph paper, etc.

PART II.

CHAPTER XIV.

ON COLLODION NEGATIVES.

We have seen, in the introductory chapter, that a negative is a kind of type, or *matrix*, by which an indefinite number of positive pictures on paper, can be produced, by means of a peculiar printing process.

In both the positive and negative collodion pictures, it has been remarked, that the whites, when viewed by transmitted light, are opaque, and the blacks transparent. We speak only of collodion pictures on glass. If such a picture is placed on a piece of paper, prepared in such manner that it blackens when exposed to the action of light, the rays of light will pass through the dark, or transparent parts of the glass, and impress the paper; in the light, or opaque parts, no reduction will take place. Through the middle tints, the light will of course blacken the paper, more or less, according to the degree of transparency. The picture, thus obtained upon the paper, will give a natural representation of the object, as it appears to the eye, and is termed "*a positive on paper.*"

Although all collodion pictures, made on transparent surfaces, present the negative aspect as well as the positive, yet all can not be used to produce "positives

on paper." A picture that is seen with advantage by reflected light, that is to say, as a positive, has never intensity enough to give a good print.

A "positive on paper," made with it, will be very feeble, or will be dark in the white parts, and wanting in the middle tints. Therefore, a negative requires, that the deposit of silver should be proportionately thicker than in the case of a positive.

To give good positives on paper, the negatives have to be transparent in the dark parts, and of such intensity in the very light parts, that a ray of light can with difficulty be transmitted, and this must be combined with a natural gradation in the middle tints. This is obtained, 1st, By using collodion thicker than for positives, and by using it colorless, or yellow, and without hydrobromic acid. 2d, By using a more concentrated silver bath. 3d, By having the bath neutral, or only slightly acid, by acetic acid. 4th, By having a certain quantity of nitrite, or acetate of silver in the bath, so as to facilitate the reduction. 5th, By giving a longer exposure in the camera. 6th, By using less acid in the developer. 7th, By a subsequent process of strengthening.

The absolute intensity of a negative does not entirely depend upon the thickness of the deposit of metallic silver, but to a great extent on the color it has when viewed by transmitted light.

We have seen, already, that the iodide of silver is impressed with difficulty by the yellow, orange, and red colors. So it is with the chloride of silver that

is on the positive paper, prepared by the ordinary process. Now, some negatives are translucent, and of a brown yellow; others of a dark bluish black; others are grey, etc. It is easily understood, that a brown yellow negative will be a great deal more opaque to the chemical rays, than one that is gray, supposing the deposit, in both cases, has the same thickness; so that, oftentimes, negatives, having comparatively a slight intensity, will give very good positive proofs.

The color of negatives depends on so many causes, that it is impossible to determine them all. The condition of the bath, the nature of the developer, the quantity of acetic acid contained in the developer, the presence or absence of organic matter in the silver bath, the time of exposure to light, are the principal causes. No positive rules can, therefore, be given, to determine whether a negative is intense enough, or not. This can only well be seen, when a positive has been produced from it. A few days practice will, however, teach, on this particular part, more satisfactorily, than what can be given in written instruction.

CHAPTER XV.

ON THE NEGATIVE COLLODION.

ANY one of the collodions given in the second chapter will answer. For negatives, it is advantageous to have films tolerably dense. If the film is too transparent, add a little more cotton. Creamy opaque films are, however, to be avoided, except when working with a

tolerably acid bath; and in that case it is recommended to increase the strength of the bath to 50 or 55 grains to the ounce. With a neutral or slightly acid bath, a degree lower than the creamy opaque film is to be recommended. In this case, use 40 or 45 grains nitrate of silver to the ounce of water.

Soluble paper in place of soluble cotton is preferred by many operators. Pyroxyline prepared from paper is supposed to give more intensity.

If collodion prepared with 4 or 5 grains of cotton to the ounce gives a wavy surface, it argues that the pyroxyline is inferior; in this case, add from 5 to 10 drops of chloroform to the ounce. If flakes of iodide of silver peel off in the bath, the collodion is over-iodized. This is also the case, but to a smaller extent, if the collodion does not give any intensity—the image being flat and on the surface, so that when dry it can be dusted off with a blender. In both these cases add more cotton or paper; or, if the collodion would not bear a further addition of cotton, add plain collodion.

If this does not give the required intensity, test the bath, and if very acid, neutralize it with oxide of silver or carbonate of soda, or add 5 or 10 grains more of nitrate of silver to the ounce of water.

If the contrast between lights and shadows is too great — that is to say, if the light parts are very intense when the details are not distinctly marked in the shadows — increase slightly the amount of iodide and bromide in the collodion. This is often the case when the collodion is very acid.

CHAPTER XVI.

THE SILVER BATH FOR NEGATIVES.

THE following is the formula for a 40 grain bath:

Dissolve 1200 grains nitrate of silver in 10 ounces water. Dissolve 12 grains iodide of potassium and 6 of bromide of potassium in 10 other ounces of water. Mix the two solutions together, add 10 more ounces of water, and let it settle. Test with litmus paper. If the paper remains blue, add one or two drops of acetic acid. If it becomes red (it is evidence that the nitrate of silver used was acid), decant the clear part, and put into the bath, drop after drop, a solution of 60 grains carbonate of soda in 1 ounce of water, until the liquid becomes permanently turbid; then filter through cotton and add 3 or 4 drops of acetic acid.

This bath must be filled up with a solution of one ounce nitrate of silver in 8 ounces of water.

When red or brown collodion is constantly used, and the appearance of the negatives is pale, without the required intensity, the bath has to be tested, and if found very acid, one or two drops of the above solution of carbonate of soda should then be added.

Test again the next day, and if still very acid, add a couple of drops more, and so continue until the larger part of the acid has been removed. It is not advisable to push the neutralizing of the bath too far, for fear of making it alkaline. If the litmus paper becomes only red after ten or fifteen minutes' immersion, it will

be prudent to discontinue the addition of the carbonate of soda solution.

The use of brown collodion develops nitric acid in the bath, which is very injurious. If a small quantity of acetate of soda or acetate of silver is added to the bath, the nitric acid will take the place of the acetic, and the acetic acid will be set free; the acetic acid being a great deal less injurious than the nitric, the bath will be improved in this way.

It must be observed, whenever acid or alkali is added to the bath, that it does not produce its full effects until the day following such additions.

The ordinary nitrate of silver sold in this country, contains a certain quantity of nitrite of silver. (See 4th Part.) This nitrite of silver is very objectionable when the production of positives is required, but is beneficial in the negative process. It acts as an accelerator, and gives great intensity to the picture.

Acetate of silver has the same effect, but to a smaller degree. Instead of acetate of silver, acetate of soda can be used. (See Part IV., Chemistry of Nitrite and Acetate of Silver).

CHAPTER XVII.

THE DEVELOPING SOLUTION.

Two different substances are used to develop collodion negatives: the protosulphate of iron and the pyrogallic acid. The former is used most generally in this coun-

try; the latter is used generally by the English and French operators.

Each of these developing agents possesses advantages peculiar to itself. The protosulphate of iron requires only one-third of the sitting time that is required with the pyrogallic acid; but the latter generally gives pictures more intense, of a better gradation of tone, and of softer appearance than the former.

The protosulphate of iron develops very rapidly; the pyrogallic acid develops slowly. The time of exposure to light must be calculated with greater accuracy when the sulphate of iron is used, because the development, being very rapid, can not be checked when the sitting has been too long, nor can it be pushed further when it has been too short.

When developing with pyrogallic acid, on the contrary, the development can be checked with more facility, and when too short a sitting has been given, the bringing out of the picture can be "pushed." But from this, the operator must not, however, conclude that the time of sitting is not of much importance in the latter case; the advantage gained with the pyrogallic acid is, that he has more latitude in the sitting time of his impression.

To a skillful artist we should, therefore, recommend the use of pyrogallic acid, when its expense and the sitting time are not an object. A beginner will succeed best by using protosulphate of iron.

The protosulphate of iron can be used alone; simply dissolved in water, it will develop negatives. It is,

however, recommended to add some alcohol to cause it to flow evenly, and a small quantity of acetic acid to prevent it from decomposing, also to give more transparency to the shadows.

This is the formula we generally use:

Protosulphate of iron	1 ounce.
Water	20 "
Alcohol	2 "
Acetic acid, No. 8	½ "

Pyrogallic acid, being a strictly neutral substance, would act with too much violence, and produce decomposition of the silver, all over the plate, if a certain quantity of acetic acid is not added to it.

The following solution may be used:

Water	1 ounce, fluid.
Pyrogallic acid	1½ grains.
Alcohol	1 drachm.
Acetic acid, No. 8	1 "

In warm weather, the quantity of acetic acid may be increased, and in cold weather it may be diminished, or the proportion of pyrogallic acid increased. The alcohol is added to make the solution flow more evenly over the plate. This solution decomposes after a few days, and becomes brown, so that it is advisable to make only a small quantity at a time. If, however, made four or five times more concentrated than it is required for use, it will keep longer. In such case it can be diluted with pure water as required.

The water used for the developer is required to be pure, soft spring, rain, or distilled water.

CHAPTER XVIII.

THE FIXING SOLUTION.

ANY of the two fixing solutions employed for positives, can be used for negatives. We prefer always using cyanide of potassium, it being more economical, and easier washed from the plate, than the hyposulphate of soda.

In its use, observe that it is diluted to such a point, that it will dissolve the unreduced iodide of silver, without attacking the film itself.

Negatives, developed with pyrogallic acid, are more easily attacked by the cyanide, than those developed with protosulphate of iron. If, however, the cyanide takes more than half a minute to fix a whole size plate, no fear need be entertained in regard to its use, when the pyrogallic acid was employed in developing.

CHAPTER XIX.

PRACTICAL DETAILS FOR THE NEGATIVE PROCESS.

IT will not be necessary to say anything in regard to the formation of the film of collodio-iodide of silver, in the negative process; it being done in exactly the same way as for positives.

The exposure to light of a negative is never less than twice the time required to make a positive. The rule is, to expose until the feeblest radiations are marked

in holding the plate up against the light. When pyrogallic acid is used, it requires three times longer exposure than with the iron salt.

As regards the development of the picture, it is about the same as with positives, when protosulphate of iron is used; but very different when developed with pyrogallic acid. When positive pictures are to be produced, it is necessary to stop the development at a certain period, in order to have good blacks; when negatives are required, the developing has to be carried to its utmost limit, provided the sitting time has been given right. This is the case, both with protosulphate of iron, and with pyrogallic acid.

The development with the protosulphate of iron is easier and quicker; the image appearing almost immediately. It is important not to throw the developer off too soon, but let it remain on the plate, until it does not produce any further change. If after being developed and fixed, it has not intensity enough to give good prints, it must be strengthened. (See Chapter XX.)

When developing with pyrogallic acid, hold the plate in the hand, or put it into a dish of its size, and pour on the developing fluid, in sufficient quantity to cover the whole surface. After one or two minutes, the image will have reached its maximum of intensity.

If the image thus examined by transmitted light, does not seem intense enough, take a fresh supply of the developing solution, and add to it a quantity of the nitrate bath, in proportion of 15 or 20 drops to the ounce of developer; mix well, and push the picture with

this, until the image has attained the required intensity. The glass that has contained the mixture of pyrogallic acid and nitrate of silver, should be carefully washed out after each operation; the black deposit that forms in it causes the fresh solution to decompose.

The *pushing* of the negative with pyrogallic acid and nitrate of silver, can be done also after the fixing; but in this case, it is better to strengthen with bichloride of mercury and hydrosulphate of ammonia, as is spoken of in the following chapter.

A plate that has not been exposed long enough to the light, develops slowly. If pushed with pyrogallic acid, and fixed, the high lights are found to be very opaque, and the shadows transparent; but the half tones are not well marked. When protosulphate of iron has been used, the image will have the same appearance, except that the silver will not be reduced as much on the high lights.

When a negative has been over-exposed, the development proceeds rapidly, and no distinct image can be seen by reflected light; viewed by transmitted light there is a want of proper contrast between the high lights and the shadows, so that the picture appears flat

After the image has been developed, the plate must be washed, and the fixing done in the same way as with positives. If the negative is designed only to make a few prints, it will, after being well washed and drained, require to be coated with a solution of one drachm of gum Arabic in two ounces of water (this solution must

be filtered before using), then allowed to dry in a place free from dust.

When the negative has to furnish a large number of prints, it will be necessary to varnish it. Anthony's negative varnish, Humphrey's gilding, or Scovill's ambrotype varnish, are good. When too thick, they will have to be diluted with strong alcohol, or chloroform. It should be poured on, in the same manner as the collodion, and the varnished plate will require to be exposed to moderate heat until the spirit has evaporated, to prevent the surface from chilling.

CHAPTER XX.

STRENGTHENING OF THE NEGATIVE.

It is often the case, more especially when the protosulphate of iron has been used as the developer, that the picture obtained (although the feeblest radiations have been impressed) has not intensity enough to yield good positives, in which case, the proof must be submitted to a process by which its intensity may be increased. Several methods prevail.

1st. *Treatment of the Image by Bichloride of Mercury and Sulphuretted Hydrogen, or Hydrosulphate of Ammonia.*—Professor Donny, of the University of Ghent, has proposed this method: The film, before it is dry, must be converted, partially or entirely, into the

double chloride of mercury and silver, by the application of a solution of a bichloride of mercury, in the same way as for whitening the positives; then washed thoroughly, and treated with a solution of sulphuretted hydrogen, or hydrosulphate of ammonia.

During the action of the bichloride of mercury on the film, the operator should inspect the picture from time to time by holding it to the light. When the required intensity is obtained, the action of the bichloride should be stopped by washing. If the bichloride is allowed to remain too long on the picture, all the little shades in the whites will disappear.

On the application of sulphuretted hydrogen or hydrosulphate of ammonia, the white image blackens immediately, the double chloride of silver and mercury being transformed into sulphuret of silver and sulphuret of mercury. When it has blackened all through, so that no trace of the former white image can be seen on the side of the glass, the picture should be washed; it has then to be dried and varnished in the ordinary way.

The solution of bichloride of mercury should not be too strong, in order to prevent the action from being too rapid. One part of the saturated solution with two parts water is sufficient. The saturated solution is made by digesting an excess of bichloride of mercury with water.

The solution of sulphuretted hydrogen not keeping longer than one or two weeks, it is not advisable for professional operators to use it.

The hydrosulphate of ammonia, as it is found in drug

stores, keeps long, and in using it, it should be diluted with ten parts of water.

The latter part of this process of strengthening should be done out of doors, as the smell of sulphuretted hydrogen and hydrosulphate of ammonia is very disagreeable, and the presence of one of these gases in the working room is sufficient to cause fogginess of the pictures.

Instead of sulphuretted hydrogen or hydrosulphate of ammonia, a very dilute solution of the hyposulphate of soda may be used, also a dilute solution of ammonia; but in this latter case the blackened image will become white again when exposed in the printing frame to the warmth of a summer sun.

This white compound (double chloride of silver and mercury), transmitting the light, destroys the impression for printing purposes. The negative will be of no more value unless blackened again, which is impossible when once it is varnished.

The composition of the film, when treated according to Professor Donny's directions, is, as we have seen, a sulphuret of silver with a sulphuret of mercury. It is the same when treated with hyposulphate of soda instead of hydrosulphate of ammonia. As to the composition of the compound obtained in treating of the double chloride of silver and mercury with ammonia, this has not yet been determined. The negatives obtained thus are of a brownish yellow color by transmitted light, and are very opaque, obstructing the passage of the chemical rays.

Messrs. M.M. Baneswill and Davanna's Process.—The image formed of metallic silver is converted into iodide of silver by treating with a solution of iodine in water; it is then washed, exposed to the light, and treated with the ordinary solution of pyrogallic acid, to which has been added a few drops of the silver bath. It is then washed, dried, and varnished in the ordinary way.

CHAPTER XXI.

IMPERFECTION IN COLLODION PHOTOGRAPHS.

In the arrangement of this chapter, we have followed the order adopted by M. Hardwick, in his Photographic Chemistry, this order being very rational, and giving great facility in the investigation.

This chapter is divided into three sections:

1st. Imperfections common to positive and negative photographs.

2d. Imperfections peculiar to positives.

And, 3d. Imperfections peculiar to negatives.

SECTION I.

Imperfections peculiar to Positives and Negatives.—These are fogging, spots, and markings of all kinds.

Fogging.—The causes which produce fogging are of three different kinds:

1st. Irregular action of the light.

2d. Impurity of the chemicals.

3d. Want of relation between the different solutions used.

1st. *Irregular action of the light. Over-exposure of the plate.*—**A.** This is often the case with beginners, who do not know the sensitiveness of the collodion process. Over-exposure gives only the appearance of fogginess, when three or four times longer sitting is given than what is required. If the plate is not so much over-exposed, the image is pale and flat in the lights and misty in the shadows.

B. *Too much light in the dark room.*—1st, Owing to the orange pane of glass through which the light is admitted into the dark room, being too pale. It is best to work by transmitted light, through either two thicknesses of orange, or one of orange and one of red glass combined. 2d, By the light of the candle or lamp being too strong. When the film is very sensitive, it is prudent to keep the lamp screened by an orange glass.

C. *Light Entering in the Camera, or in the Tablet.*

D. *Direct Light of the Sun falling upon the Lens.*

E. *Diffused Light of the Sky falling upon the Lens.*—This is often the case when taking views. Put on the mouth of the object glass a tube seven or eight inches long and blackened inside. In this way there will be admitted only the rays proceeding directly from the object exposed. The diffusion produced by the lateral light will be avoided. The same result may be obtained in using a diaphragm with a small aperture, placed two or three inches distant from the lens.

2d.—*Impurity of the Chemicals.*—**A.** Use of fused nitrate of silver, in preparing the bath. The fogging is caused by the excess of nitrite of silver. When positives are to be produced, add a few drops of nitric acid; when the bath is to be used for negatives, add acetic acid.

Generally, the crystaline nitrate of silver of commerce, contains also nitrite of silver. This is owing to the mode of preparation. Baths prepared according to our formulæ will not present this inconvenience.

B. *Use of Alkaline Collodion.*—Collodion can be alkalined by the use of iodide of potassium, which contains carbonate of pctash, as it is sometimes the case. Alkaline collodion is always colorless; it restores the blue to reddened litmus paper. The remedy is to put in a few drops of hydrobromic acid, so as to give it a pale yellow color.

Collodion prepared with iodide or bromide of cadmium remains colorless, too, when the ether, alcohol, and gun cotton are free from acid. This is not, however, a mark of alkalinity, but of neutrality. A few drops of hydrobromic acid can only do such collodion good, when it is used with a neutral bath.

C. *Alkalinity of the Bath.*—The bath becomes alkaline when an excess of carbonate of soda, or of any other alkali is added to it for the purpose of neutralizing the acid. In this case, filter and add nitric acid for positives, and acetic acid for negatives, until it does not, by a long immersion, restore the blue color to reddened litmus paper.

The use of rain-water to make the bath, can render it alkaline, by the ammonia which it contains when not filtered on charcoal. Hard water, containing *carbonate of lime*, will produce the same effect. This carbonate of lime is not removed by filtering.

D. *Decomposition in the Bath by Exposure to Light.*—Add nitric acid, a small quantity at a time; let it stand for half a day after each addition, and then try it. If the half tones are injured, increase the strength of the bath, and iodize more highly the collodion.

E. *Introduction of Pyrogallic Acid, Sulphate of Iron, Hyposulphite of Soda, Organic Matter (such as dust, etc.), into the Bath.*—Add a few drops of nitric acid; let it stand, and the next day try the bath. If it does not work, add more nitric acid.

If a large china evaporating dish is convenient, boil your bath for five or ten minutes after each addition of nitric acid. It can in this case be tried immediately.

F. *Vapors of Ammonia, Sulphuretted Hydrogen, Hydrosulphate of Ammonia, etc., in the Dark Room.*—Fumigate with chloride of lime, or chloride of soda.

G. *Redipping the Plate into the Silver Bath before Developing it.*—Let the plate drain very thoroughly.

H. *Imperfect Cleaning of the Glass.*—In this case a reduction is observed between the collodion film and the glass. It results often from the cleaning rags not being dry, or soiled with the developing or fixing solution.

3d. *Want of Relation between the Different Solutions Used.*—**A.** The bath is too strong for the collodion, or the collodion too feeble for the bath.

B. The quantity of cotton is too small, or the quantity of iodizing is too large—in other words, the collodion is over-iodized.

We will distinguish, in the over-iodizing, several degrees. 1st, The over-iodizing is such that flakes of iodide of silver are liberated in the bath. The picture, instead of being in the collodion film, is on the surface, and can be washed off without the collodion film being injured. 2d, The collodion is not so much over-iodized. No iodide of silver is lost in the bath, but the picture is yet on the surface. 3d, A part of the picture is in the film; another part is so loose on the surface that it can be dusted off with a blender; in this instance the over-iodizing is smaller than in the other cases.

In these three cases the picture has a foggy appearance.

C. The use of a developing solution containing too little acid, or too much sulphate of iron.

Spots.—Spots are opaque or transparent by transmitted light; white or black by reflected light.

Opaque Spots are Produced.—**A.** By collodion having small particles in suspension. Specks having the appearance of a comet are produced by this. At other times little circular specks are produced, which, by washing, leave a hole or spot by transparency on the film. The collodion should always be allowed to settle before using it.

B. By not cleaning the mouth of the bottle, so that fragments of dried collodion are floated on the plate.

C. By a deposit formed on the side of the gutta

percha bath, or by the solution not being well filtered.

D. By dust on the glass in the tablet, or in the camera, or by moving the slide in and out of the tablet with violence, so that small particles of organic matter, or drippings of the plate. are spattered on the film.

Transparent spots are produced, **A,** *by the Silver Bath being Turbid*—Small particles of iodide of silver being in suspension in it. See page 39. Filter and add a small quantity of nitrate of silver.

B. *Small particles of iodide of silver, or of iodide or bromide of potassium in the collodion.*—Allow it to settle, or add one drop of water.

C. *By pouring the developer on entirely at one spot, so that the nitrate of silver is washed off, and the development prevented in that place.*

Markings of various kinds.—**A.** *A reticulated appearance of the film, after developing and fixing.*—When forming a regular network, all over the plate, it is caused by the collodion being rotten, by decomposition, or from excess of water. If partial and irregular, and mostly on the side where the collodion was poured off, the markings are caused by the plate being dipped into the bath before the film was set.

B. *Perpendicular lines traversing the plate*—Are produced when a collodion, iodized to its maximum, is used with a silver bath, entirely saturated with iodide and bromide of silver. As we have seen, the larger the proportion of cotton is, in the collodion, the greater the quantity of iodizing may be. The remedy is, to add

nitrate of silver to the bath and filter. But better:—Put into the silver solution three or four ounces of water. The bath will become turbid, and will deposit the iodide and bromide of silver; filter, and add to the clear solution a quantity of nitrate of silver corresponding to the quantity of water added: that is to say, add three or four times 20, 30 or 40 grains nitrate of silver, according to the strength of the solution. It is also an improvement to add a little more cotton to the collodion.

C. *Straight lines traversing the film horizontally*—Are caused by checks having been made during the immersing of the plate into the bath.

D. *Oily spots, or lines*—Occur when the plate is taken out of the silver bath, before the ether and alcohol have been washed away. They are also caused by developing the plate without draining, after it has been dipped into the bath a second time. Marks of the same shape occur, also, when the developer does not amalgamate readily with the surface of the film — in which case add more alcohol to the developer.

F. *An uneven film of iodide of silver is produced*—1st, When the collodion contains too much ether, so that it dries too soon. 2d, When the collodion is made with a bad sample of cotton. 3d, When it is too thick.

In the first case, leave the bottle open for some time, in order to allow the excess of ether to evaporate. In the second, add ten or twelve drops of chloroform to the ounce. In the third case, dilute with the relative parts of iodized ether and alcohol.

G. *Curved lines, of irregular development, result*—

1st, From an excess of protosulphate of iron, or pyrogallic acid. 2d, From using too little acetic acid. 3d, From not covering the entire film with sufficient rapidity, so that the action commences in spots, before the surface is entirely covered. 4th, From using too small a quantity of fluid to develop, so that the plate is not equally covered with it.

H. *Stains on the upper part of the plate.* — This results from using a dirty tablet. The nitrate of silver that is in excess on the plate, runs down and comes into contact with the wood; it is then, by capillary attraction, drawn on the plate, and decomposes under the influence of the developer. To avoid this: 1st, Let the plate drain, before it is put into the tablet, and wipe the lower edge with cotton, etc. 2d, Clean the tablet after each operation. 3d, Varnish the holders, daily, with gum shellac dissolved in alcohol.

SECTION II.

Imperfections peculiar to Positives.—**A.** *The Image shows well in the high lights, but the shadows are dark and heavy.*—This may be the result of several causes. 1st, Under exposure. 2d, Under development. 3d, The different solutions are either too neutral, or too strong. Thick collodion, with a neutral 40 grain bath, will always give too great a contrast between lights and shadows. The remedy is to make the bath slightly acid. 4th, The quantity of nitric acid in the bath is too large for the strength of the bath, and the proportion of iodizing in the collodion. Increase the quantity of nitrate of silver in the bath, and add more iodizing to the

collodion. Decreasing the quantity of acid in the developer, will aid in bringing out details and shadows. 5th, The developer contains too much nitric or acetic acid.

B. *The shadows of the image are good, but the lights are burned.*—This is produced by the three last causes given in A, or by over-development.

C. *The image is flat in the high lights, or misty in the shadows.*—This results from over-exposure. To a larger extent, over-exposure produces fogginess.

D. *The shadows are covered with little specks, similar to those produced on daguerreotypes, by leaving them too long on the mercury.*—The image is over-developed. Such over-developing is produced only when much acid is present in the bath, or in the developer.

In ordinary conditions, the over-development takes the appearance of mistiness in the shadows, and of solarization in the lights.

ECTION III.

Imperfections peculiar to Negatives. Sulphate of Iron used as a Developer.—**A.** The image is not intense enough, the gradation of tone not being well observed. The bath is too weak, or the collodion too much iodized in proportion to its amount of gun cotton. In which case, strengthen by one of the given processes.

B. *The picture is intense enough in the light parts, but the shadows are not sufficiently marked.*—The picture is under-exposed, or the amount of iodizing is too small in proportion to the quantity of gun cotton used, and the strength of the bath.

C. *The picture is intense all over, but not sufficient contrast exists between its lights and shadows.*—It is over-exposed.

Imperfections peculiar to negatives, developed with pyrogallic acid.—**A.** *The image is distinct, and the gradation of tone good; but it is not intense enough to print well.*—The development must be pushed with pyrogallic acid and nitrate of silver, or the bath made stronger, or the collodion was too much iodized for the proportion of cotton it contains.

B. *The picture is very intense in the lights, but the shadows are not marked.*—In which case the image is under-exposed, and pushed in the development.

C. *The image is red and misty, and without vigor.*—Then the image has been exposed to light, or is very much over-exposed in the camera.

PART III.

CHAPTER XXII.

POSITIVES ON PAPER.

Two methods are adopted to produce positives on paper. 1st, The ordinary positive process in which the silver is reduced directly by the light on a paper plate; and 2d, the process called negative, because it is used, also, to produce negatives on paper, in which the silver is reduced by the subsequent action of light and of a developer.

In the ordinary positive process, the paper is immersed into a solution of chloride of sodium or chloride of ammonium, then in a solution of nitrate of silver, so that by double decomposition chloride of silver is produced. It is now in the proper condition for exposure under the negative to the light, until a sufficient reduction has taken place; after which the not reduced chloride of silver is dissolved by a solution of hyposulphite of soda.

In this process called *negative*, the paper is floated on a solution of iodide or bromide of potassium, and then on a solution of nitrate of silver. Having placed it under the negative, expose it to the light and develop by means of gallic acid. The not reduced iodide of silver is finally dissolved by the hyposulphite of soda.

Selection of the Paper.—The ordinary paper containing substances that are injurious in the photographic operation, and being of an unequal texture, is unfit for use. Several papers have been manufactured purposely, and these can be found in most of the stock depots.

A good photographic paper is smooth, uniform in texture, of an equal thickness in every part, and free from spots. The smoothest side should be used to receive the impression, and the opposite side marked with a pencil.

DIRECT POSITIVE PROCESS.

CHAPTER XXIII.

THE SALTING OF THE PAPER.

Plain Salted Paper.—Float the paper for four minutes on a solution of 15 grains chloride of sodium or chloride of ammonium dissolved in one ounce of water, and hang it up to dry. For this purpose, the patent clothes pins answer admirably. Prepare in this manner, one after another, as many papers as you may desire to make prints. Take care that no air bubbles keep the liquid from penetrating uniformly the paper. One grain of purified gelatine may be added to this solution. It will improve the blacks and add to the firmness of the paper. It should be dissolved by warming slightly the solution.

Albuminized paper may be found ready prepared in the trade. That made by Marion, of Paris, is of a superior quality.

Take the whites of fresh eggs, and beat them with a bundle of quills, until the whole becomes a perfect froth. Take the froth off and allow it to pass again into the liquid state in a dish set in a cool place, free from dust; then pour it into a vial-shaped bottle and allow it to settle.

Take of the clear part one ounce, and mix it with from one to four ounces of water, according to the gloss you want to obtain. Finally, to each ounce of this liquid add 15 grains of chloride of sodium, or better, chloride of ammonium. The paper must be floated on this solution for four minutes. Thin paper should be preferred for albuminizing.

Serum Paper.—The serum is prepared in the following way: Take one quart of milk, boil it, and when boiling add to it 10 or 20 drops acetic acid, No. 8. The milk coagulates immediately. It must then be strained through a cloth to separate the liquid which is the serum. The serum thus obtained must be clarified with albumen. For this purpose, add to it when cold a well beaten white of an egg, and place it over a slow fire. The albumen will coagulate and retain in its network all the impurities. It must then again be strained through a cloth, and finally filtered through Swedish or the best filtering paper.

In each ounce of this serum thus obtained, dissolve 15 grains chloride of sodium, or of chloride of ammo-

nium; add to it half drachm alcohol and float on it the paper in the ordinary manner. One grain to the ounce of gelatine may be added. The gelatine will have to be previously dissolved in a small quantity of water.

CHAPTER XXIV.

SENSITIZING OF THE PAPER.

THE ordinary nitrate bath is composed of 60 grains nitrate of silver dissolved in one ounce of water. When the negative is not intense enough to give good prints with one of the above named salted papers and the ordinary nitrate bath, a solution of ammonia nitrate of silver should be prepared.

This is done in the following way: Dissolve 40 grains nitrate of silver in one ounce of water, and add to it ammonia, drop after drop, agitating, meanwhile, with a glass rod. A brown precipitate of oxide of silver will form, which will, on the addition of more ammonia, be dissolved. When the liquid has become clear, it will contain an excess of ammonia; to prevent this, add to it a few crystals of nitrate of silver dissolved in a small quantity of water, so as to render the liquid turbid. It must then be filtered and kept in a dark place.

Albuminized paper and paper prepared with serum of milk, do not give good results with this solution. The plain salted paper, with or without gelatine, is the article to be used. The ammonia nitrate bath gives more sensitiveness and greater contrasts between whites

and blacks than the ordinary silver solution. It will thus give the best results with feeble negatives.

The paper can be sensitized by floating it on the silver solution, or by applying the silver solution on the paper by means of a brush or of a piece of cotton. The use of the brush is adopted when large papers are used, or when the paper has to be sensitized with ammonia nitrate of silver.

To sensitize a paper by floating, take it by the two opposite corners, and having bent it into a curved form, lay it on the silver solution, the lower part touching firstly, and lowering gradually down in order to press the air bubbles from under.

When air bubbles form between the paper and the liquid, repeat the same operation until they have disappeared. To apply the nitrate of silver on the paper, a brush or a tuft of cotton fixed on a glass rod is used. The paper should be laid on a sheet of blotting paper, and then wetted with the solution, firstly lengthways and then across. Be careful to use nitrate solution enough to transform all the chloride of sodium or of ammonium into the chloride of silver.

The reason why it is preferable to apply the ammonia nitrate on the paper instead of floating the paper on the solution, is, that by the reaction of the chloride of sodium on the ammonia nitrate of silver, ammonia is set free and dissolves in the solution, which in this way takes an excess from the first paper that is floated. This excess of ammonia has the effect to give a red tone to the picture when it is not strongly printed.

When the ammonia nitrate has to be used in a bath, it is then necessary to take that excess of ammonia away, and this is done by adding, after each paper has been floated, a few crystals of nitrate of silver, so as to render the solution turbid, and then filtering.

It is useless to say that the paper must be sensitized, and dried, and kept in a dark place. Paper prepared with ammonia nitrate of silver, will keep only one day; the ordinary paper will keep longer.

The silver solution on which albuminized or gelatinized paper has been floated, soon becomes brown. To prevent this, it is useful to keep in the bottle which contains it, one or two ounces of kaolin, or China clay. Pure animal charcoal will answer the same purpose.

CHAPTER XXV.

THE PRINTING.

PRINTING frames, of different forms, are sold by stock dealers. They are constructed in such a way that they can be opened, and half of the picture examined without disturbing its position. The negative is laid in the frame, the collodion side uppermost; the sensitive paper is then placed upon it, and the shutter placed upon the sensitive paper. It is then pressed together tightly by the screws, or by the springs.

It is necessary to put a piece of black cloth between the paper and the shutter. This operation may be done

in diffused day light. The printing frame is then laid in the sun-light, or in the diffused light, in such a position that the rays of light fall perpendicularly on the plate.

The time of exposure is very variable; it depends, 1st, on the sensitiveness of the paper; 2nd, on the strength of the light; 3d, on the intensity of the negative. The print should be taken out when it appears slightly darker than it is intended to remain, the hyposulphite reducing its intensity. A little practice will soon teach the operator how far the printing has to be pushed.

CHAPTER XXVI.

FIXING AND TONING OF THE PRINTS.

WHEN the paper has been removed from the printing frame, it should be immersed in the following solution, taking care to remove the air bubbles: In 4 ounces of water dissolve 3 ounces hyposulphite of soda; and in 4 other ounces of water dissolve 4 grains chloride of gold; then pour the second solution into the first. Upon immersing in this solution the color of the prints will immediately be altered; and after from fifteen minutes to two hours immersion will have taken the required colored.

The color depends much on the time of immersion. The purple tones are an early stage of coloration; the

black tones are a more advanced one. Albumen prints, however, will be difficult to bring to the black tones without the whites losing their purity. Ammonia nitrate, with gelatine paper, is the best to use when black prints are required.

While at the same time that this bath colors the positives, it fixes them ; that is to say, it dissolves away the chloride of silver that has not been reduced by the action of light. The fixing is done when the paper presents, by transparence, an uniform appearance.

Instead of using this fixing and toning solution, it is preferable to do the fixing and toning separately. For this purpose, after removing the print from the frame, wash it several times with clear water, so as to dissolve all the nitrate of silver it contains ; then immerse it in the following solution :

No. 1.—Hyposulphite of soda ..... 3 grains.
Water ..... 2 ounces.

No. 2.—Chloride of Gold ..... 2 grains.
Water ..... 2 ounces.

Pour No. 2 into No. 1, and add 5 drops hydrochloric acid.

If the print is not well washed, the nitrate of silver it still contains will form a precipitate in the toning-bath. To prevent this, it is recommended to wash, finally, with water containing a small quantity of salt, so as to transform the remaining nitrate of silver into chloride; then to wash again with clear water.

Place the washed print in the toning solution, and allow it to remain in it for two or three minutes. It will, at first, take a dark-red purple tint, and then a violet tint approaching to black. After that, the print has to be washed again, and fixed in a solution of one part hyposulphite of soda in 4 parts water. This solution changes the tone of the print slightly.

Four ounces of the above given toning solution is sufficient to tone twelve whole-size pictures.

CHAPTER XXVII.

WASHING, DRYING, AND MOUNTING.

It is essential to wash out of the print all the hyposulphite of soda it contains, in order to prevent it from fading. This washing should be done either in running water or in a dish, changing the water very frequently.

It is prudent to continue the washing for four or five hours. The print has finally to be dried between blotting paper, or by hanging it up. If not well washed, the water that drains from the edge will produce a precipitate in a solution of bichloride of mercury, or render it turbid. It is important, in order to do the washing well, to place each print in a separate dish.

The print being dried, has, ordinarily, to be mounted on paste-board. This is done by applying to the back side of the print, a solution of gum, or gelatine, in

water, and then sticking it on the paste-board. Use it as feeble as possible, and be careful not to use gum solution that has become sour.

CHAPTER XXVIII.

IMPERFECTIONS IN DIRECT POSITIVES ON PAPER.

A. If the print has a faded and yellow appearance, the hyposulphite is acid, or too old and weak; or the print has been left in it too long a time, or has been washed too slowly.

B. If not sufficient contrast exists between the lights and shadows, the print being pale, and without vigor, then the nitrate bath is too weak in proportion to the salt solution.

C. If too much contrast exists between the lights and the shadows, the details are not marked in the latter. Then increase the proportion of salt.

D. If pale spots appear, then there has been insufficient absorption of the nitrate of silver by the paper; this may result from the unequal texture of the paper, or from the silver bath being too weak.

E. Black spots are caused by dust on the surface of the silver solution, organic matter on the paper, or metallic particles in the paper.

CHAPTER XXIX.

PRODUCTION OF POSITIVE PICTURES BY THE NEGATIVE PROCESS.

Iodizing of the Paper.—The paper used should be the same as for the direct positive process. It should be, firstly, floated for two or three minutes on the following solution:

Iodide of potassium	8 grains.
Gelatine	1 grain.
Water	1 ounce.

Then hang up to dry.

Sensitizing of the Paper.—

Nitrate of silver	20 grains.
Acetic acid, No. 8	2 drachms.
Water	1 ounce.

Float the iodized paper for three minutes on this bath, or brush the solution on the paper, by means of a tuft of cotton; then hang up to dry.

This work should be done by orange light. The light of a candle is too strong, and should only come through a yellow, or orange pane of glass.

Exposition to Light.—The paper has to be exposed behind the negative in the same way as for printing positives, by the direct process. This operation must be done in the dark room. The picture should be exposed to diffused light, until a faint image is seen. This takes, sometimes, only a few seconds. The picture should only be examined in the dark room.

Developing.—Make a saturated solution of gallic acid, filter it through the best filtering paper, and apply it, with a tuft of cotton, on the paper; the image will develop rapidly. When fully developed, wash with plenty of water, then with a weak solution of gold, and then again with water.

Toning, Fixing, and Washing.—The toning should be done in the gold bath, spoken of page 84, and the fixing in a solution of 1 ounce hyposulphite of soda, in 4 ounces of water.

The washing should be conducted with the same care as in the direct positive process.

PART IV.

CHEMISTRY OF THE DIFFERENT CHEMICALS USED.

Acetic Acid.—Acetic acid is the acid of vinegar. It is produced by the oxidation of the alcohol contained in beer, wine, etc., and by the distillation of wood.

The most concentrated acetic acid is known as *glacial*, because it crystalizes at a moderately low temperature. It contains only a small quantity of water. It is used to a small extent, being sold at a high price.

The acetic acid known as No. 8, is generally used in its place. It contains 25 to 35 per cent. pure acid. The acetic acid used in photography, should be free from sulphuric, sulphurous, and hydrochloric acids. If sulphuric acid is present, a drop of a solution of nitrate of baryta, will produce a white precipitate of sulphate of baryta, which is insoluble in nitric acid. A drop of a solution of nitrate of silver, will produce a white precipitate, if hydrochloric or sulphurous acid is present.

Acetate of Silver.—This is a very decomposable salt of silver, and is used sometimes in the negative silver bath. Being very sparingly soluble in water, and less so in a solution of nitrate of silver, only $\frac{1}{4}$ grain to the ounce of silver solution should be added.

Acetate of soda may be used in its place, and in the same proportion.

Alcohol.—The specific gravity of the ordinary alcohol of the trade is, usually, about .840, and contains from 80 to 83 per cent. pure, or absolute alcohol.

Alcohol, distilled on carbonate of potash, contains, ordinarily, 90 per cent. pure spirit. Its specific gravity is .823. Anhydrous, or absolute alcohol, has a specific gravity of .794, and does not contain any water. It is obtained by mixing alcohol .823, with an equal weight of pulverized quick lime, letting it digest for several days, and then distilling.

Alcohol, 90 per cent., will do for the preparation of collodion, if pure, concentrated sulphuric ether is used. If the ether is not highly concentrated, use alcohol 95 per cent.

If no other than ordinary alcohol can be found, as is often the case in country places, digest one quart of it with 5 or 6 ounces powdered quick lime, and after three or four days decant the clear part for use.

This alcohol is slightly alkaline; but its alkalinity may be removed by adding to the collodion prepared with it, 2 or 3 drops of hydrobromic acid. Alcohol possessing a bad, or whisky smell, should be discarded.

Alkali.—Such is the name given to combinations of certain metals with oxygen, which have, to a high degree, the property to restore the blue color to litmus paper, which has been reddened by acids. Such are the caustic potash, and soda, which are the oxides of

potassium, and sodium. Ammonia, or alkali, is the oxide of a hypothetic compound, called ammonium.

Carbonates, or combinations of carbonic acid with oxides, possess alkaline properties. Such are the carbonates of potash, soda, ammonia, silver. Oxides, although they are not all alkalies, still possess alkaline properties to a certain extent. The oxide of silver, which is soluble in a solution of nitrate of silver, will communicate to this solution the property of restoring the blue color to reddened litmus paper.

Ammonia.—What is known as *ammonia*, is a solution of ammoniacal gas in water. It is used in photography to prepare the ammoniacal silver bath, for the production of positives on paper. The pure ammonia, only, should be used.

Bichloride of Mercury.—This salt is one of the most virulent poisons, and should be handled with the utmost precaution. It is used in photography to whiten positive pictures on glass, and ambrotypes; or to strengthen negatives. The ordinary salt found in drug-stores, is sufficiently pure.

Bromine.—The ordinary bromine of daguerreotypists is used for the production of hydrobromic acid.—

Bromide of Ammonium.—This salt is sparingly soluble in alcohol, and is used in the preparation of collodion.

Bromide of Cadmium.—Bromide of cadmium is very soluble in alcohol, and is added to collodion, without being previously dissolved in water.

Bromide of Potassium—Crystalizes in cubes, and is anhydrous. It is very soluble in water, but sparingly in alcohol.

Bromide of Silver.—The bromide of silver is more sensible to the red, orange, and yellow rays, than the iodide. It is formed by mixing a solution of a bromide with a solution of nitrate of silver.

In dissolving the bromides of potassium, ammonium, or cadmium, in the collodion, this bromide of silver is formed on the collodionized plate.

Carbonate of Soda.—Known in the trade as *washing soda*, but it is in an impure state. It is used for the neutralization of the silver bath.

Carbonate of Potash.—This salt is used for the concentration of alcohol and ether. It may be used to clean greasy glasses instead of caustic potash.

Animal Charcoal.—Animal charcoal is used in photography to discolor the silver solutions that have been colored by the use of albuminized or gelatinized paper.

It is important to use for this purpose the pure charcoal—the one that has been deprived of its phosphates and carbonates, by repeated digestions in hydrochloric acid.

Vegetable Charcoal.—Vegetable charcoal possesses the discoloring properties of the animal charcoal, but to a less extent. It should, when used for such purposes, be burnt, firstly, and then pulverized.

China Clay, or Kaolin—Is perfectly insoluble in water and acids, and produces no decomposition in a solution of nitrate of silver. It is used in photography

for the same purpose as charcoal, to remove the color from solutions of nitrate of silver.

Chloride of Ammonium—Known in the trade as *sal ammoniac*, and is sold in colorless and translucent lumps. It dissolves very readily in water, and is also soluble in alcohol. It is used in preference to chloride of sodium (common salt), in the preparation of the positive paper, because it does not attract the humidity of the atmosphere, as does the chloride of sodium. This salt is pure enough for photographic purposes in its ordinary state.

Chloride of Silver—Is formed when mixing a soluble chloride with a soluble salt of silver. It forms the sensitive compound in the ordinary positive paper.

Chloride of Sodium, or Common Salt.—It is used in photography to prepare the ordinary positive paper. It absorbs the moisture of the air, so that paper salted with it will keep a shorter time than the paper salted with chloride of ammonium.

Chloride of Gold.—Chloride of gold is used to tone the positive pictures on paper. It is prepared by submitting gold to the action of aqua regia—that is, in a mixture of one part nitric acid and three parts hydrochloric acid—and warming gently. The gold will dissolve, liberating vapors of chlorine and nitrous acid. The excess of liquid has then to be evaporated, and the chloride remains in crystaline form.

Cyanide of Potassium.—Two kinds of cyanide of potassium are found in the trade, the crystaline and the fused. The latter, although containing, sometimes,

50 and 60 per cent. carbonate of potash and other impurities, is, however, generally employed in photography.

This salt is a virulent poison and should be handled with precaution, that it does not come in contact with sores or scratches on the hands. When used to remove stains of nitrate of silver from the hands, it should be thoroughly washed off.

Gallic Acid.—Gallic acid is obtained principally from gall nuts, by exposing them. when powdered, to the combined action of air and moisture, and boiling then th mass with water, the gallic acid is dissolved, and being less soluble in cold water than in hot, crystalizes on cooling in form of long silky needles.

The liquid must be filtered before it is allowed to cool.

Gallic acid dissolves in 100 parts of cold water, and in 3 parts of boiling water. It dissolves also in alcohol. The aqueous solution soon decomposes; therefore, it is recommended to keep it in solution in alcohol, and to mix with water only when required for use. A few drops acetic acid will, to a certain extent, keep the aqueous solution from decomposition. Gallic acid is used as a developer in the negative paper process.

Gelatine —Gelatine is insoluble in cold water; it is soluble in boiling water, and takes the form of a jelly when cold. The ordinary carpenters' glue is an impure gelatine. It is extracted from bones, horns, skins, and other animal matter. The kind known as *isinglass* is prepared out of the air-bladders of fish. The kind

which is required in photography is the purified, and must be transparent, colorless, and without any disagreeable smell.

Gutta Percha.—Gutta percha is extensively used for manufacturing horizontal and vertical dishes, funnels, etc. These materials should always be cleaned with diluted nitric acid, then washed.

Hydrobromic Acid.—Its uses in photography and its preparations have been given, page 14.

Hydrochloric Acid.—That which is known in the trade as hydrochloric or muriatic acid, is a solution of hydrochloric acid in water. Hydrochloric acid is a gaseous substance of a penetrating smell, which is soluble in a little less than two parts of its weight of water.

It is prepared by treating chloride of sodium or common salt with sulphuric acid. The pure solution of hydrochloric acid is colorless, but as it is found in commerce it is always of a yellow color. This depends on the perchloride of iron produced by the action of the acid on the iron retorts in which it is made. When the solution of hydrochloric acid is strong, it fumes in the air.

Hydrosulphuric Acid or Sulphuretted Hydrogen.—This gas has a peculiar putrid smell, and is poisonous. It is soluble in one-third of its volume of cold water; but the solution soon decomposes, and deposits sulphur in very fine powder. It is used to strengthen the negatives. Its presence in the work-room should be avoided, as it transforms all the compounds of silver into black sulphuret of silver.

It is prepared, in treating sulphuret of iron, by diluted sulphuric acid.

Hydrosulphate of Ammonia—Is a gas having a still more putrid smell than the hydrosulphuric acid. Its solution is used to strengthen negatives.

Hyposulphite of Soda.—This salt is mainly used in photography to fix positive pictures, on paper.

In the positives and negatives, on glass, it is also used by some; but it is preferable to use the cyanide of potassium, which is more readily removed from the surface of the film.

Hypochloride of Lime—Known in trade, improperly, as the *chloride of lime*. It is very useful for fumigation. If vapors of ammonia, or sulphuretted hydrogen, are liberated in the air of the working-room, the simple presence of the hypochloride of lime is sufficient to counteract them. It acts by liberating chlorine in the atmosphere. When vinegar is poured on it, its action is much more energetic.

Hypochloride of Potash—Improperly called *chloride of potash*, possesses the same advantages as chloride of lime in photography.

Iodine.—Iodine is extracted from the ashes of sea-weeds. It is contained in small quantities in the waters of the ocean, in the form of iodide of sodium and of magnesium.

Daguerrean artists are very well acquainted with its appearance. It is sparingly soluble in water; more largely in alcohol and ether. The alcoholic solution of iodine is known as tincture of iodine.

Iodide of Ammonium.—This salt is used in iodizing collodion, and it is claimed that it gives more sensitiveness than do the other iodides. It being very decomposable, may produce more rapidly than any other iodide this first stage of decomposition, which is so favorable to sensitiveness.

Iodide of Ammonium, when first prepared, is white; but under the influence of light and air it soon decomposes, and becomes, at first, yellow, and then red. This discoloration is produced by the liberation of free iodine; but it does not produce any inconvenience until it has attained the red color.

In this latter stage it will communicate its color to the collodion.

The color of iodide of ammonium can be easily removed with a few drops of alcohol.

In this operation it is important to leave the alcohol only a short time in contact with the salt, in order that it may dissolve the smallest possible quantity of it.

Another way to render the iodide of ammonium colorless, is to warm it slightly on a piece of silver plate, or on a glass, in order to evaporate the iodine.

In both these cases, the iodide of ammonium is as good as when it is newly prepared.

Iodide of Cadmium.—This salt crystalizes in beautiful flakes, of a pearly luster. As sold by dealers it is very pure. It is soluble in the collodion menstruum.

Iodide of Iron.—The preparation of iodide of iron has been given, page 21. It is employed to give more rapidity to collodion.

Iodide of Potassium.—This salt is white, crystalizes in large cubes, very soluble in water; to a slight extent in alcohol. It absorbs the moisture of the air, and must be kept in tightly corked bottles.

This salt is sometimes impure; the impurities it contains are the carbonates of potash, or chloride of potassium. The first may be detected, 1st, by its alkaline reaction on reddened litmus paper; 2nd, by the property it possesses to continue colorless when a drop of tincture of iodine is added to it and shaken.

The chloride of potassium may be detected in the following way. Dissolve a small crystal of the supposed impure iodide of potassium in water; add a few drops of a solution of nitrate of silver, in order to precipitate all the iodide and chloride in the state of iodide and chloride of silver; then let it settle, and add a few drops of ammonia. If the chloride of potassium is present, it will be dissolved by the ammonia, and can be precipitated by adding a small quantity of nitric acid.

The alcohol, 95 per cent., not dissolving any sulphate or carbonate of potash, a solution of iodide of potassium in alcohol, of that strength, is sufficiently pure for all photographic purposes.

Iodide of Silver.—This salt is formed when a soluble iodide is mixed with a solution of a salt of silver. It precipitates in the state of an impalpable powder, slightly yellow, without taste or smell. It is insoluble in water, but soluble in cyanide of potassium and hyposulphite of soda. It is also slightly soluble in solutions of nitrate of silver, of iodides of potassium, and ammonium.

It is formed in the collodion film, and in the paper used to print positives by the negative process.

Lime.—There are two kinds of lime—the anhydrous or unslaked lime, and the hydrate or slaked lime. The former is used for the concentration of alcohol and ether.

Litmus.—Litmus is of a blue color, and is obtained in small cubes. It has the property of being reddened by the action of an acid. Its blue color is again restored by an alkali.

The litmus paper is prepared by dissolving the litmus in warm water, and soaking in this solution sheets of paper. To prepare the red paper used for the detection of alkalinity, the blue papers are soaked in water slightly acidulated with sulphuric, nitric, or hydrochloric acid.

Nitric Acid.—The ordinary nitric acid of commerce will not answer for the preparation of pyroxyline, because it is too weak. It will not answer to make nitrate of silver, nor to add to the developing solution, because it contains hydrochloric acid. Pure nitric acid should be procured for these last two purposes.

If hydrochloric acid is present, a white precipitate of chloride of silver will be formed by the addition of one or two drops of the silver bath to the nitric acid.

Nitrate of Potash.—This salt is known by the name of *nitre*. It is used in photography for the preparation of gun cotton, or pyroxyline, and sometimes it is added to the developing solution. For the preparation of gun cotton, refined nitre is required.

The article that is added to the developing solution must be very free of chloride of sodium, and of any other chloride. The presence of a chloride can be easily detected by dissolving a small quantity in water, and then adding one or two drops of a solution of nitrate of silver. If any chloride is present, a white precipitate of chloride of silver will be formed, which, after shaking, will settle to the bottom. This is chloride of silver, and is soluble in ammonia.

Nitrate of Silver.—The nitrate of silver is a compound of oxide of silver and nitric acid. It crystalizes in square white and transparent plates, which are anhydrous and very heavy. When pure, it is not affected by air. It is soluble in an equal weight of water at the ordinary temperature, and in half its weight of boiling water. It corrodes the skin and stains it black. Its solution is perfectly neutral, neither reddening the litmus paper nor restoring the blue color to that which has been reddened with an acid.

Sometimes the nitrate of silver found in the trade is acid by the presence of nitric acid. This can easily be detected by its solution reddening the litmus paper. If so, it should be neutralized with a solution of carbonate of soda, which should be added to the solution, drop by drop, until the liquid becomes turbid; then filtered, and a few drops acetic acid added to it. It will then be slightly acid by acetic acid; but the acetic acid does not possess the same power as the nitric, so that a small quantity of it does not sensibly change the silver bath.

Generally, the nitrate of silver sold in this country

contains nitrite of silver. This is far from being an objection when negatives are to be made, it giving both rapidity and intensity. One drop of nitric acid will change the nitrite into nitrate.

The fused nitrate of silver (lunar caustic) could be used very well in photography if it was not so often adulterated with nitrate of potash. It contains a certain quantity of nitrite of silver.

The preparation of the nitrate of silver is very simple. Take one part by weight of pure silver—or, if that can not be obtained, silver coin may be used; put this silver into a china dish and pour on it two parts by weight of pure nitric acid diluted with two parts of water, and warm gently with a spirit lamp. This has to be done in the open air. It will be advantageous to cover the dish with a glass funnel, in order to prevent the liquid from being projected out of it by boiling. The silver will dissolve rapidly, giving a colorless solution if pure silver has been used, and a green solution in case the silver was alloyed with copper.

If the quantity of nitric acid is not sufficient to dissolve all the silver, add some more until a complete solution is effected, and boil down to dryness. Then increase the heat until all the nitrate has fused, and pour it on a daguerrean plate.

If the silver used was mixed with copper, the nitrate will have to be fused for some time in order to decompose the nitrate of copper. When the heat is increased, the mass blackens and emits vapors of nitrous acid, which is a proof that the nitrate of copper is decompos-

ing. Continue the heat until all has become one liquid, and has ceased to emit vapors.

It will be necessary to warm the dish all over, so as to decompose the nitrate of copper that is in contact with its sides. To determine whether the reduction of nitrate of copper is complete, take a small quantity of the fused mass on the extremity of a glass rod, dissolve it in a few drops of distilled water and put into it three or four drops of ammonia. If the solution does not become blue, the nitrate of copper is decomposed.

If the crystalized nitrate of silver is wanted, dissolve the fused nitrate in as small a quantity of water as possible; then filter and evaporate in a china dish until the liquid is reduced to half its volume; then place it in a quiet and cool place to crystalize.

The crystals are to be taken out the next day, and dried by laying them on blotting paper. The remaining liquid must be evaporated again and set to crystalize.

Nitrate of Baryta.—This salt is used to detect the presence of sulphuric acid or of a sulphate, with which it gives a white precipitate of sulphate of baryta, insoluble in nitric acid. When the quantity of sulphuric acid or of a sulphate is very small, it only renders the liquid turbid.

Nitrite of Silver.—Nitrite of silver is always present in strongly fused nitrate of silver. It is an accelerator for negative pictures, to which it gives a great intensity. This salt, which is a compound of oxide of silver and nitrous acid, is sparingly soluble in water, and crystalizes in long needles.

Oxide of Silver.—Oxide of silver is a brown insoluble powder, which is precipitated by adding a solution of caustic potash to a solution of nitrate of silver. It has then to be washed several times with clean water, and finally spread out to dry on blotting paper.

It is used to neutralize silver baths, in combining with the free nitric acid they may contain.

Potash (Caustic).—Caustic potash is a combination of the metal potassium with oxygen. What is known generally as *potash* in the trade is the real potash combined with carbonic acid or *carbonate of potash.*

Caustic potash is very soluble in water. Its solution is known as *liquor potassæ* by the druggists. It is very beneficial for the purpose of cleaning greasy glass. This solution should not be kept in a bottle with a ground glass stopper, as it attacks the glass, and renders it impossible to take out the stopper after having been in for some time.

Protosulphate of Iron.—This salt is known in the trade as copperas, or green vitriol. It has the form of prismatic green crystals, which become yellow and efflorescent by being exposed to the air. It is used as a developer for collodion pictures.

The commercial protosulphate of iron is not quite pure enough for photographic purposes. A second crystalization will make it fit for use.

Protonitrate of Iron.—Protonitrate of iron is also used as a developer for collodion pictures. It is very unstable, its solution decomposing by the contact of air, and taking a rusty color. It is prepared by precipitat-

ing 320 grains sulphate of iron dissolved in two ounces of water, in a solution of 300 grains nitrate of baryta in two other ounces of water. The liquid, filtered, is a solution of protonitrate of iron.

It is also formed in small quantities by mixing nitrate of potash in a solution of protosulphate of iron. It gives very good results, and its use would be highly recommended if it was not so expensive, and so liable to decomposition.

Pyrogallic Acid.—Pyrogallic acid is obtained by the action of heat on gallic acid. Gallic acid is formed by decomposition and oxidation of a principle contained in the gall nuts, and called *tannic acid.*

When pulverized gall nuts are exposed to the combined action of air and moisture, the gallic acid is produced. If then they are heated at a temperature of from 400 to 420, the gallic acid is decomposed into the pyrogallic acid, which sublimates in white lamalar crystals.

Many vegetable substances contain tannic acid, the original principle from which gallic and pyrogallic acids are formed. The bark of the oak, and the hull of the walnut contains it in rather a large quantity.

When the heat used to transform gallic into pyrogallic acid is too intense, *metagallic* acid is formed. Commercial pyrogallic acid often contains metagallic acid. This may easily be detected, by the brown color it gives to its mixture with pyrogallic acid, and by its insolubility in water.

Although termed an acid, pyrogallic acid is a neutral

substance, not reddening the litmus paper. As we have observed, it is used to develop negatives. It is very soluble in water.

Pyroxyline, or Gun Cotton.—Pyroxyline is the result of the action of nitric acid on cotton, paper, or other ligneous substances. The nitric acid used in its preparation must be particularly strong, since the weak nitric acid dissolves the cotton and paper at the same time that it alters their chemical composition.

The strongest nitric acid, that contains only one atom of water, is not sufficiently strong.

To have the nitric acid particularly strong when it acts on the cotton, two modes are adopted; 1st, by mixing strong sulphuric acid with dry pulverized nitrate of potash; 2nd, by mixing one part of sulphuric acid with one part strong nitric acid. Each of the mixtures we will, hereafter, term—*Nitro-sulphuric Acid.*

Several varieties of pyroxyline are produced, which differ in composition and in their qualities, according to the strength of the nitro-sulphuric acid used. 1st, Cotton that is very explosive, burns without a residuum, is insoluble in a mixture of alcohol and sulphuric ether. 2nd, Cotton that is less explosive, and leaves, when burned, a small quantity of black ashes, and is entirely soluble in a mixture of alcohol and ether. 3d, Cotton that is not explosive, and, burning, leaves large residuum of black ashes, is partly soluble in a mixture of alcohol and ether, and gives, upon evaporation, an opalescent film.

No. 1 is obtained when the nitro-sulphuric acid is very

strong. It is the real gun cotton, the one required for projectile purposes.

No. 2 is obtained when the nitro-sulphuric acid is weaker than in the previous case. It is the one used in photography.

No. 3 is obtained when the nitro-sulphuric acid is still weaker. It has no use.

No. 2 is the one in which we are interested. Two means exist, as we have already said, to make nitro-sulphuric acid. 1st, by mixing sulphuric acid with nitrate of potash; 2nd, by mixing sulphuric acid with nitric acid.

Preparation of the Gun Cotton with a mixture of Nitric and Sulphuric Acid.—The nitro-sulphuric acid must be made of such a strength that it will give a pyroxyline possessing the qualities of the No. 2. For this purpose take very dry nitrate of potash, and reduce it to a fine powder. The substance sold as Dupont's refined nitre, is the best. Next to this, "sal prunelle," of the druggists. If the saltpetre is not very dry, put it in the oven of a stove for some time. Of this dried nitrate of potash take 2½ ounces (apothecaries' weight), put it in a porcelain mortar, and pour on it three fluid ounces of the strongest sulphuric acid, and 2½ or 3 fluid drachms of water. Then stir this thoroughly together, until the whole forms a fluid pasty mass, when immerse in it, a small quantity at a time, 80 grains of fine, white, washed cotton; knead the cotton in the mixture from three to five minutes.

During this operation, dense, suffocating fumes will

be given off; so that it should be performed in the open air, the operator being to the windward, or in some place where there is sufficient draught to carry away the injurious fumes. The cotton having been thoroughly kneaded, so as to bring every fiber in contact with the mixture, it may be lifted out, by means of a glass rod, and thrown into a pail of water. After stirring it for a few moments, pour off the acidulated water, and fill the bucket again with fresh water, and wash thoroughly, repeating this operation several times, until no more acid remains in the cotton. This can easily be detected with litmus paper.

The cotton being thus washed, squeeze it out as thoroughly as possible, place it between the folds of a clean towel and wring it. It might then be pulled apart and laid in the sun or in a warm place to dry; however, remember that it explodes spontaneously at a heat of 212° F.

If in a hurry to use the cotton, put it into a small quantity of alcohol, in order to remove the remaining water; then wring it out in a clean towel and allow it to dry or dissolve immediately.

The cotton treated in this way will dry much quicker than when not washed in alcohol. The alcohol thus used is still suitable to burn.

The success of this operation depends, 1st, On the purity and dryness of the nitrate of potash; 2d, On the degree to which the nitrate of potash has been pulverized; 3d, On the strength of the sulphuric acid. If the nitrate of potash was not very dry, it will have the

same effect as if the quantity of water was too great; if it was not well pulverized, the nitric acid will not be all set free, so that it would be the same as if the quantity of nitre was too small.

The acid must be so strong that it has a specific gravity of 1.833; if weaker, the quantity of water should be lessened, or the water should be omitted altogether.

If, in using no water, the cotton gelatinizes and is partly dissolved, the sulphuric acid is too weak and should be rejected. If such is the case when the given quantity of water is added, lessening or omitting it will perhaps prove a remedy.

Mr. Hadow recommends the following formula when no pure nitre can be obtained:

Selected crystals of commercial nitre powdered and dried ..... 510 grains.
Sulphuric acid ..... 15½ drachms.
Water ..... 1½ "

The mixture is very fluid and transparent, so that the manipulation is easy. This formula is less successful than the first one.

It is necessary to immerse the cotton in the mixture of nitre and sulphuric acid immediately after it has been made. If allowed to cool so that its temperature is less than 140° F., the cotton that is obtained (supposing all the other conditions are fulfilled) will be soluble in the mixture of alcohol and ether without gelatinizing, and will give a thick solution, producing a wavy and opalescent film.

The cotton made at the proper temperature, on the contrary, gelatinizes on immersion in the alcohol and ether, and gives a fluid solution producing an even and transparent film.

Preparation of Pyroxyline by means of the mixture of Nitric and Sulphuric Acids.—When acids can be obtained of the proper strength, this mode is recommended on account of the facility of the manipulation and the constant success with which it is followed; particularly when Tagliabue's Collodiometer is used. Without this instrument, it is as uncertain as the process with nitre and sulphuric acid.

Take the strongest sulphuric acid that can be found (it should be at least 1.820), and test it by the bulb No. 1 of the collodiometer. The testing of acid should be done at the temperature of about 60°. A thermometer accompanies the collodiometer for this special purpose.

If the bulb floats in the liquid without coming to the surface, the acid is of the proper strength; if it goes down to the bottom, it is too weak; if it floats on the surface, it is too strong. In this last case, it should be diluted with a small quantity of water, then allowed to cool until it falls to 60°, and tested again. If still too strong, add more water. This, however, must not be done until the nitric acid has been tested by its proper bulb No. 2, in the same manner as the sulphuric acid was tested with No, 1, because the nitric acid may be, from excess of water, a little too weak. The extra strength of the sulphuric acid may in such a case be

counterbalanced by the weakness of the nitric acid. On the other hand, if the bulb No. 1 goes down in the sulphuric acid, it should not be rejected until the nitric acid has been tested and found to be only of the required strength. This strength of the nitric acid is about 1.420.

When the bulb No. 1 floats in the sulphuric and bulb No. 2 in the nitric acid, bulb No. 3 will float in a mixture of equal parts of sulphuric and nitric acids at the temperature of 140° or 150° F. If one of the acids is too strong and the other too weak, mix them together by equal quantities, and test them with bulb No. 3, which is to float in the mixture and not at the surface, when the excess of water in one compensates for the want of it in the other acid. When bulb No. 3 goes down, the mixture of the two acids is too weak. If, however, it can be made to float by the addition of a small quantity of sulphuric acid, it may be used. The cotton will be of inferior quality, if it is necessary to add much sulphuric acid for this purpose.

If the acid mixture is too strong—that is to say, if bulb No. 3 floats on the surface—add the quantity of water necessary to make it float in the liquid, paying attention to add only a small quantity at a time, and to agitate and test after each addition.

Use always the thermometer when testing, and test at 60° with bulb No. 1 or 2, and at 140° or 150° with bulb No. 3.

This mixture of the two acids has to be made in a vessel that can be covered up with a pane of glass or a

cover during the operation, so as to prevent the vapors from rising into the atmosphere.

It is best not to use more than 20 grains of cotton to the ounce of nitro-sulphuric acid. If more is used, the cotton will be compressed too much, and will decompose by the great heat generated, so that red vapors of nitrous acid will be produced. When these fumes arise, rapidly stir the mixture with a glass rod. The same effect will be produced when the temperature of the nitro-sulphuric acid is too high, and when the cotton is put in, in too large quantities at a time.

It is in all circumstances, the more common when the nitro-sulphuric acid is of just such a strength, that if it was a little weaker it would not answer the purpose.

Four or five minutes immersion is sufficient to transform the cotton into pyroxyline. The nitro-sulphuric acid should then be poured off, and pressed out of the cotton with a glass rod, and the cotton thrown into a bucket of water and agitated, then washed rapidly and dried as has been described.

The nitro-sulphuric acid may be used a second time; and will produce a very good cotton, although a little inferior to the first article.

For using the mixture the second time, immediately after it has been used, and without allowing it to cool, add to it about one-fourth of its volume of strong sulphuric acid. Sulphuric acid in which bulb No. 1 would go down will not answer. This addition will raise the temperature. Wait until it is raised to 140°, or 150°

Fahrenheit, and then immerge the cotton in the ordinary way.

With the aid of the three bulbs above spoken of, the production of pyroxyline is almost infallible. We have prepared, in this way, from twenty to twenty-five pounds of cotton, two or three ounces at a time, without a single failure. The result is certainly not the same when sulphuric acid and nitre are used, as every operator will readily admit.

It is often the case that cotton is not entirely soluble. This may be produced by two causes. Either the nitro-sulphuric acid is a little too strong, so that a small quantity of the insoluble No. 1 gun cotton is produced, or it is too weak; and then it is the No. 3; or No. 2 more or less mixed with the No. 3. See following page. It is very easy to detect by which cause it is produced, by observing the properties of the different kinds of pyroxyline which are obtained. If No. 1 is present, it will explode without leaving much ashes, and that portion of the cotton which dissolves will give a thin collodion, yielding an even transparent film. If No. 3 is present, on the contrary, it will give a wavy opalescent film, and will burn, leaving a quantity of black ashes.

In the first case, so much of the cotton as dissolves will be of good quality, and in the second it is worthless. Therefore it is an error to think that all which dissolves is good, and that which is not good will not dissolve.

The pyroxyline No. 2 is the only sample that can be used. It does not matter if it is mixed with No. 1, which is insoluble; but that is very objectionable which is mixed in large quantities with No. 3, as it is partially soluble, and gives an opalescent film.

In manufacturing pyroxyline, all depends on proper proportions of acids being observed. We even suspect that the temperature of 140 or 150°, required to make good soluble cotton, is only necessary to give to the sulphuric acid more power to absorb the one atom of water of the nitric acid, at the moment of the immersion of the cotton.

The cotton obtained by acids of the proper strength, but used at a low temperature, has very much the character of the No. 3; and nitro-sulphuric acid that is too strong when used warm, and gives the No. 1, will very often give soluble cotton when used at a temperature of 60°.

In regard to the use of Swedish, or Joseph paper, it must be cut into strips, and immersed in the same way as cotton.

It is said that it gives a better pyroxyline, and one that gives more intensity in negatives. The washing must be done with much more care than when cotton is the fabric employed.

Sulphuret of Silver.—Sulphuret of silver is a combination of silver with sulphur. It is a black insoluble powder, and is formed, 1st, by the direct action of sulphur on silver; 2nd, by the action of sulphuretted hydrogen, or an hydrosulphate, on silver, or on any salt of silver.

Sulphuret of silver is soluble in ammonia, cyanide of potassium, hyposulphite of soda, etc. Nitric acid converts it into sulphate and nitrate of silver.

Sulphuric Acid.—The sulphuric acid, as it is found in commerce, is combined with water, and is known as *vitrol*, or *oil of vitrol.*

This is a dense and transparent oily fluid, sometimes colorless, and again colored brown by organic matter. It corrodes the skin, but not so readily as nitric acid. It distills only at 620 Farenheit, and does not fume in the air, as the strong nitric or hydrochloric acid.

When diluted with water, it attacks and dissolves zinc, iron, etc. The strong acid has no action on metals when cold (alkaline metals excepted), but dissolves most of them when heated, transforming them into sulphates.

Sulphuric acid possesses great affinity for water, and combines with it in producing heat. Its action in the manufacture of gun cotton is to deprive the nitric acid of its water. The sulphuric acid should be as strong as possible for this purpose. For developing solutions, etc., the ordinary is very good.

Sulphuric Ether.—This ether is a transparent and colorless liquid, which is very volatile, boiling at 98° Fahrenheit.

The specific gravity, when very pure and free from water, is about 720. Its vapor is very heavy, and may be seen falling down when the bottle which contains ether is opened. It is produced in distilling a mixture of alcohol and sulphuric acid.

It is soluble in ten volumes water, and dissolves a small quantity of the liquid. When mixed with water, in large proportions, and shaken together, there will be formed two layers. The lower portion of the volume is water, containing in solution one-tenth of its volume of ether; the higher part is ether, containing in solution a small quantity of water. This ether decanted by means of a syphon, is known by the name of *washed ether.*

Water.—Distilled water is recommended for silver baths. If this cannot be procured, use rain water collected in clean vessels. River or spring water may be used for all the other solutions.

APPENDIX.

Manner of Separating the Silver from old Collodion Silver Baths, from the Nitrate of Silver Solution, used in preparing Positive Paper, and from the Water that has been used to wash the Prints, before the immersion in the Chloride of Gold, etc.

To the liquid containing the silver add a solution of common salt, until no milkiness is perceptible. This will precipitate the silver, in the state of a chloride.

After shaking well, allow this chloride of silver to settle, when the liquid should be poured away, and the precipitate washed several times in clean water. The larger part of the water should now be poured off, and a piece of clean zinc put into the bottle, to which add a few drachms of sulphuric acid. The mixture will immediately effervesce. The zinc is dissolved in a short time, and the chloride of silver will be transformed into metallic silver, in the state of a black powder.

There should be an excess of zinc in the liquid, in order to effect the transformation of all the chloride of

silver into metallic silver. This change of the chloride to the metallic state, commences first with that which is in contact with the zinc, which becomes immediately black. It must now stand without shaking, until all the chloride of silver has become uniformly black, when the remaining zinc should be taken out, the liquid poured off, and the silver washed two or three times with water acidulated with sulphuric acid, and finally with clean water.

The silver can be separated from the water, by filtering through paper, and is pure. It can be used to prepare nitrate of silver.

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APPENDIX

TO THE SECOND EDITION.

Simple method for Printing by Development, Large Pictures from Small Negatives.

DISPOSITION OF THE APPARATUS.

The apparatus necessary for throwing up from half size or whole size negatives, are:

1st. An ordinary camera tube. When small negatives are used a quarter or half size will be sufficient; but, if the negatives are large, it will be necessary to have a whole size tube, as a tube of smaller size has not reach enough, and would not reproduce the parts away from the center with sufficient sharpness and without distortion.

2nd. A camera box composed of two parts, the one sliding into the other. When a half size tube is used, each of these parts should be about six inches long. For the whole size tube they have to be one or two inches longer, tho focus of a whole size instrument being so much longer. In the place where in the ordinary camera, is the ground glass, should be a contrivance to slide in the negative. The box should be about eight by ten inches.

3rd. A looking glass, swinging in the middle and turning on a pivot in front of the box. The

center on which it turns and swings should be on a level with the axis of the lens.

4th. A dish for iodizing and silvering, a little larger than the picture you want to print. The most economical dishes, and the best and cleanest, are composed of a framework in which a plate of glass is sealed with a cement composed of equal parts of rosin and beeswax. The sides of the framework should be about four inches high and one inch thick. In these sides is a groove half an inch deep and a quarter of an inch wide. The framework is fastened together with screws. Join firstly three pieces, then slide the plate of glass into the groove, and screw on the fourth piece. After that pour into the groove your melted cement, and finally varnish the wood several times with shellac dissolved in alcohol, or with copal varnish. These dishes can be used on both sides, and are very easily cleaned. This is done firstly with a clean sponge, and then the dish is put with one corner into a bucket, and water poured over.

5th. A stand made on the same principle as a painter's easel, with the difference that it is perpendicular. It has to be about six feet high and two and a half feet wide. The sides have to be parallel. The part on which the dish containing the prepared paper rests, slides up and down, and is fastened with a catch. The stand is kept steady by a brace.

6th. A wooden dish for fixing and washing, made watertight by pouring the beeswax and rosin

cement in the corners, and varnished with shellac or copal. A dish of the same description as the one used for iodizing and silvering will answer the same.

The tube and box should be put in a hole made in a dark room exposed to the south, in such a way that the tube faces the stand on which to put the prepared paper. The negative is put in the slide, and behind it is a ground glass, in order not to have the disk of the sun reflected on the paper. It will be remarked that in this disposition the tube is reversed, so that the front lens is nearest the sensitized surface, and the back lens nearest the negative. This is the disposition to be adopted in all cases where copies have to be made larger than the original. It is recommended to put a mat in front of the negative so as to cover the parts that have not to be printed, and not to admit more diffused light in the dark room than is necessary.

To set in focus use a screen or one of the sides of the glass dish, on which you paste white paper for iodizing and silvering.

The focusing is done with the box or with the tube and with the stand. The larger the picture has to be made, the larger the distance has to be between the tube and focusing screen, and the nearer the negative has to be to the tube.

PRODUCTION OF THE IMAGE.

The best paper to be used is the German endless drawing paper, but any other kind will

answer if it is as heavy as the above named, well sized, equal in texture and free from iron rust. Thin paper will not answer, because it does not give intense prints, and because it would be torn in the process of washing it. Some kind of inferior endless paper of a blueish appearance is also found in the trade, but it cannot be used, because it contains mineral substances to make it heavy. The paper is cut a little larger than the size of the picture, and has to be treated with the following solution :

Iodide of Potassium, 1 ounce.

Chloride of Sodium, (table salt) 1 ounce.

Water, (filtered or rain,) 32 ounces fluid.

This solution, after being filtered, is poured into the glass dish. The paper has only to be passed through, taking care to avoid all air bubbles. It is not required to soak it, as it takes iodizing enough without prolonged immersion. It is then hanged up to dry by means of the patent clothes pins. The paper found in the trade is either sized with starch or with gelatine or isinglass. The one sized with starch takes after iodizing a reddish color.

This iodized paper will keep for months, but it is always best when recently prepared.

The paper being dry, is immersed in the following silver solution. This should be done by artificial light.

Nitrate of Silver, 1 ounce.

Distilled water, 12 ounces fluid.

Acetic Acid, No. 8, 1 ounce fluid.

This solution has firstly to be saturated with Iodide of Silver, if not, it dissolves the Iodide of Silver from the surface of the paper and nothing but a faint image can be obtained. Two grains of Iodide of Potassium, dissolved in a small quantity of water, will yield Iodide of Silver enough to saturate the solution. Let the paper be immerged for about five minutes. When the one sized with starch is used, it is very easy to see when all the iodizing is transformed in Iodide or Chloride of Silver, for the reddish color disappears and the paper from opaque becomes transparent. In order to have pictures free from stains and spots, the greatest cleanliness is required. The dishes have to be well washed and the solutions filtered. The silver solution has also to be in such a quantity as to enable you to pass the paper through it without pauses, otherwise lines will be produced similar to those found on Collodion plates, when checked while dipping them. After the paper has been silvered, pour off the silver solution and put the dish in the place of the screen. Fasten the upper part of it to the stand, by means of a string or an iron wire, and put a bottle and funnel under it to receive the silver solution which drains from the paper. Then turn your looking glass so as to reflect the sunlight on the negative, and see if the image is well in focus. The time of exposure cannot be given. It depends first, on the intensity of the light; second, on the intensity of the negative; third, on the size of the picture, for the larger the picture the larger the distance between the

sensitive paper and the object glass, and the feebler the light. Sometimes five minutes' exposure is enough, at other times it takes one hour. In all cases, print till you see well all the outlines of the image. Over exposure is not as much to be feared as in the Collodion process.

Next proceed to the development. Prepare a saturated solution of Gallic Acid, to which you add a few drops of Acetic Acid No. 8, to make it keep, and let it settle, or filter it. Then put some into a bottle with a wide mouth, and flow it over the paper in the same way as in developing a Collodion plate. It requires some dexterity to do this, and it will be necessary to use about a pint to develop a picture 22 by 27, but with a little practice you will be enabled to do with half this quantity. When the paper by long exposure has partially dried, use always a larger quantity of developer than otherwise, as it is difficult to flow it in this case.

In warm weather, the development proceeds very rapidly; in cold weather, it is advisable to use the developing solution at a temperature of about 90°. It can easily be brought to this temperature by keeping it behind the stove. Develop the picture till it is a little darker than you wish to have it, as it loses in the Hyposulphite, but not so much as in the ordinary printing process. It is easy to be deceived by the appearance of the proof by artificial light, for it shows always darker than by daylight. Notice will thus be taken of this in developing.

When the picture has arrived to the required intensity, the development has to be stopped. This cannot be done by washing it, the Gallic Acid and Nitrate of Silver remaining long in the paper and the development continuing while the proof is soaking in the water. The proper way is to precipitate the Silver in an insoluble state, by pouring on a solution of common salt. The salt transforms the free Nitrate of Silver into Chloride, and the development is stopped instantaneously. There is no necessity of pouring out the developing solution before adding the salt water. The Chloride of Silver thus formed can be collected and transformed into metallic silver in the ordinary way.

The picture should not be allowed to remain in the solution of salt, as the salt has the power of transforming into white Chloride the finely divided Silver which forms the image.

The proof is next fixed in a solution of one pound Hyposulphite of Soda in a half gallon of water. It should not be done in strong light, as the purity of the whites would be affected. The fixing is done when the yellow appearance given tothe paper by the non-reduced *Iodide of Silver* has disappeared by transparence. The Hyposulphite has then to be washed out with the same care as in the ordinary printing process. The easiest way is to put the proof on a muslin screen or on a board, and to let the water run over it for half an hour, changing the place of the picture and turning it from time to time, then soaking it

for two or three hours, taking care to change the water about every fifteen minutes.

The printing process as described above is free from difficulties, if the silver solution is always kept at the same strength by the addition of Nitrate of Silver. The strength can be ascertained by the means described on page 28. The actino hydrometer does not answer the purpose, as the silver solution is mixed with Acetic Acid, and after being used a while contains a quantity of Nitrate of Potash and Nitrate of Soda, which increase the specific gravity.

The solution of Gallic Acid should not be prepared in advance, unless Acetic Acid is added to it as mentioned above.

The Hyposulphite of Soda soon loses the power to fix, it having dissolved all the Iodide and Chloride of Silver it could; but if a solution of *Hydrosulphate of Ammonia* is added to it, the Silver will be all precipitated in the state of Sulphuret of Silver and the Hyposulphite will fix again. Care should be taken not to add an excess of Hydrosulphate of Ammonia. Add only a small quantity at a time, and after each addition shake and let the Sulphuret of Silver deposit on the bottom. As long as, after shaking, the peculiar smell of the Hydrosulphate is not detected, no excess has been added, but if so, add enough of old Hyposulphite to remove the smell.

When the Sulphuret of Silver has settled to the bottom, the Hyposulphite is poured off, and the Sulphuret of Silver is washed in several waters, after

which it is dried and added to the Chloride of Silver produced in stopping the development. The means of reducing these insoluble compounds of silver to the metallic state, will be described hereafter.

Dry Collodion Process.

Two different states of the sensitive Collodion film are observed. The one is the *tough* and *contractile* state. It is that given by Collodion which has been made with concentrated Ether and Alcohol, and excited with the Iodides and Bromides soluble in Ether and Alcohol. This Collodion is unfit for the dry Collodion process, it being, *when dried*, too impenetrable by the solution used to bring out the image, so that the deposit of Silver is not thick enough to give intensity.

The *sandy*, half rotten film, is the one required. It is produced by all or some of the following conditions:

1. Predominance of Alcohol.

2. Use of Iodides and Bromides requiring water to dissolve into the Collodion.

3. Liberation of free Iodine by spontaneous decomposition.

4. Use of Pyroxylin made at a high temperature, with acids having the maximum of strength, and by a long immersion.

The following formula, I have found to give good results.

Sulphuric Ether,	3½	fluid oz.,
Alcohol,	4½	" oz.,
Pyroxylin, from 35 to	50	grains,
Iodide of Potassium	40	"
Bromide of Potassium,	20	"

The Iodide and Bromide of Potassium have to be dissolved in such a quantity of water as not to be precipitated again when added to the Collodion. The quantity of water to be used cannot be determined, as it depends altogether upon the strength of the Ether and of the Alcohol. As for the quantity of cotton, this depends on the thickness the sample that is used gives to the collodion.

Some Pyroxylin gives, even when dissolved in concentrated Ether and Alcohol, and iodized with the soluble Iodides and Bromides, a film so short and rotten that it is almost useless for the wet Collodion process. When the Collodion is made with this kind, equal parts of Ether and Alcohol may be used, and it may be iodized with the iodides and bromides, which are soluble without water.

Keep the Collodion about a week before using it, when it will be found to have the required qualities to a sufficient degree.

The plate has to be cleaned with extra care and coated with Collodion in the ordinary way. Before being dipped in the silver solution, which will have to be 40 grains strong, it will also be necessary to allow it full time to *set* perfectly, more so than in the wet process. When the film of Collodio-Iodide

of Silver is formed, it is washed with filtered or rain water until the greasy appearance is gone. There is no necessity of the washing being pushed farther, as the plate would lose too much of its sensitiveness. The washing may be done either with running water or in a dish. The excess of water being drained off, coat with the *Collodion Preservative.* This preservative is prepared in the following way:

In one quart distilled water, put three drachms white Gelatine, the best you can find, and warm by means of a water bath until the Gelatine is dissolved; then, while yet warm, filter it through cotton and add four ounces of Alcohol and one ounce Acetic Acid No. 8.

This Preservative is poured on the plate and moved back and forth till an even coating is obtained, when the plate is set on one corner to dry spontaneously, in a place free from dust, or the gentle heat of an alcohol lamp may be applied, or it may be dried before the fire. It is useless to say that all this must be done at night or in a dark room. In winter it will also be necessary to use the Collodion Preservative in a warm place, and to warm it before using if it be gelatinized.

The plates remain sensitive for several weeks longer in cold than in warm weather; but success is always more constant when the plates are not kept longer than a week.

The time of exposure is about four times longer than with wet Collodion, Pyrogallic Acid being used

as a developer; and ten times, compared with Collodion used with Protosulphate of Iron.

The development of the image may be done several days after the exposure. Some use Gallic Acid as a developer, but I prefer Pyrogallic, as it shortens the time of exposure in the camera, and produces in other respects the same results.

The plate should firstly be wetted with filtered or rainwater, after which, the following solution is poured on:

Nitrate of Silver,	20 grains,
Water,	1 ounce fluid.
Alcohol,	2 drachms "
Acetic Acid No. 8,	2 drachms "

This solution furnishes the Silver which has to be reduced on the plate.

The following developing solution is applied next:

Pyrogallic Acid,	2 grains,
Water,	1 ounce fluid.
Acetic Acid No. 8,	2 drachms "
Alcohol,	2 drachms "

You may also apply the Pyrogallic Acid first and the Silver Solution afterward, or instead of using the latter you may add 15 or 20 drops of your Collodion silver bath to each ounce of developing solution. In this case this mixture will only have to be made at the moment you want to use it, and the glass that has contained it should be carefully washed out after each operation, the black deposit

that forms in it, causing the fresh solution to decompose.

The picture will be developed in from three to ten minutes. When it takes longer than that, it has been under-exposed and the result is unsatisfactory.

The developing may be done by keeping the plate by one corner, as in the wet Collodion, or you may put it on a level stand or in a dish. This last contrivance is the handiest.

When Gallic Acid is used as a developer, make a saturated solution of it, to each ounce of which you add 15 or 20 drops of a 40 grain silver solution.

Professor Smith, of Gambier College, (Ohio,) the inventor of the Melainotype, after having wetted the plate, pours over a saturated solution of Gallic Acid, and then a 15 grain silver solution, and when the image appears he continues the development with Pyrogallic Acid. Professor Smith's Collodion Preservative has also Gelatine for basis, about one ounce to a gallon. It is very good, but too expensive.

After being developed, the proof should be well washed and fixed with Hyposulphite of Soda, or with a weak solution of Cyanide of Potassium; then it should be gummed or varnished in the ordinary way.

In this process there is sometimes a tendency of the film to blister during development, and to separate from the glass. This is owing to one of the following causes:

1. The Collodion is too tough.

2. The plate has not been properly cleaned, or the edges have not been roughened.

3. The Collodion was not well enough *set* before dipping.

If the image obtained is flat and without intensity, the Collodion is too tough. None but the Collodion described above should be used, and it is also required that it give intense pictures while in the wet state.

Intensity in Negatives.

The production of intense negatives is dependant on several conditions, which are—

1. The quality and the quantity of the Pyroxylin.

2. The quantity of Iodide and Bromide in the Collodion.

3. The state of the silver solution.

4. The composition of the developer.

The quality of the Pyroxylin determines mainly the state of the film. For a Collodion to give intense pictures, it has to dry in a film that is smooth, even and easily penetrated by the deposit of Silver. The Pyroxylin giving this kind of film is made with acids having the maximum of strength, and at the proper temperature (120° to 140°). It explodes with vivacity, without leaving any ashes, or only a very small quantity. Cotton that is less explosive will not do for negatives, no matter how soluble it is. Mr. Hadow has established four different

compounds resulting from the action of Nitro-Sulphuric Acid on cotton, which he terms A, B, C, D. At page 105 of this book we have confounded compounds B and C, which are somewhat similar, being both soluble in the mixture of Alcohol and Ether. But the compound C, which is made with Nitro-Sulphuric Acid having the maximum of strength, is almost as explosive as the compound A, (genuine gun cotton) and although entirely soluble in the Collodion mixture, is dissolved with difficulty and only after considerable shaking. It gives a film short and very adherent to the glass. The compound C is far less explosive, and dissolves very readily in Ether and Alcohol, giving a film which is tough and contractile, and is penetrated with difficulty by the reducing silver. The Pyroxylin used in Photography is generally a mixture of the two compounds, but to be fit for negatives compound B has to predominate in it.

The decomposition which is going on in the Collodion by age, brings forth a state of the film favorable to intensity, so that Collodion will always improve in this respect by age.

The quantity of Iodine and Bromine present in the Collodion has not to be the maximum that the Collodion film can retain in its fibre, but a little less. When too small a quantity of iodizing is used, the image, though intense in the high lights, is deficient in the half tones. In such case add a little more iodizing. The appearance of the film when it comes out of the silver solution should be white, without being too opaque. If it was creamy

it would be wanting in intensity, and plain Collodion would have to be added.

The silver solution should not be less than 40 grains strong, and it should be free from Nitric Acid. The solution given at page 57 is excellent. If the negative should not come out clear and transparent in the shades, a few drops more Acetic Acid should be added. Acetic Acid, when used in small quantity, has no retarding influence on the formation of the image. The operator should, however, be cautious not to use it too freely, as a quantity of Acetate of Silver would be formed, which being only sparingly soluble, settles on the film in the form of little crystalline needles. This is often the case when the bath is getting weak. The remedy is to restore it to its proper strength, and to add a drop of Nitric Acid, which transforms the Acetate in Nitrate, setting Acetic Acid free again.

The developer, as we have already said, should not contain Nitric Acid, which, the same as in the silver solution, has a retarding influence and prevents the silver being reduced in sufficient quantity. Use the one given at page 60, or any of the positive developers at page 30, which do not contain Nitric Acid.

To conclude now, let us remark again that the main thing is the quality of the cotton. Before making his Collodion the operator should try if his cotton is well explosive. If it has not that character, he had better not use it, for although the Collodion made with it may acquire by age the power to give a certain intensity, still he will not be per-

fectly successful. If explosive, it may be as we have said, either the variety A or the variety B, and sometimes a mixture of the two. In this latter case the variety A (gun cotton) remains in the liquid in a feathery mass.

Mr. Moulton says, "A cotton, hanging in a light feathery mass in solution, is caused by the acid mixture being too weak." I think it is just the contrary, the feathery mass is compound A. A cotton made with Nitro-Sulphuric Acid which is too weak, dissolves partly and leaves insoluble lumps in the ground of the bottle. I never saw any of the former kind but what was highly explosive.

We will give, in the next chapter, the preparation of the negative Pyroxylin.

Preparation of Negative Pyroxylin.

We have seen that to obtain a film in which the silver is easily reduced, we have to use a Pyroxylin made with Nitro-Sulphuric Acid at the maximum of strength and at a high temperature. Such Pyroxylin gives much body to the Collodion, and produces an even, transparent and short film. Pyroxylin made at a low temperature, also gives a thick film, but one that is wavy and contractile. Another sample is very soluble and dissolves quick and makes a thin Collodion. This is mainly composed of compound C and is useless for negatives, but excellent for positives. It has been made at a high temperature with Nitro-Sulphuric Acid rela-

tively weak. Of this description is most of the soluble cotton found in the trade.

Equal parts of Sulphuric Acid 66° and Nitric Acid 44° Baume, will by about ten minutes' immersion at a temperature of 125 or 130° Fahr., give good negative cotton. These acids have not to be chemically pure; if they were a little water might be added to them, for the specific gravity of commercial Sulphuric Acid is increased by a small quantity of Sulphate of Lead, and the one of the Nitric Acid by Nitrous Acid, which it has in solution. Have your acids as near the given strength as possible. If the Nitric Acid was a little too weak the quantity of Sulphuric Acid might be increased; if it was too strong, it might be diminished, or the Nitric Acid might be mixed with a weaker sample. Endeavor always to have strong Sulphuric Acid, for if it was weak it would be necessary to have stronger Nitric than the one marked 44° Baume, which is very difficult to find, and the mixing of the two acids would not give the proper degree of warmth.

If the cotton obtained is very explosive, but partly insoluble, the Nitro-Sulphuric Acid is too strong and should be weakened, either by using less Sulphuric Acid, or by reducing the strength of the Nitric. If the cotton is soluble without being explosive, the Nitro-Sulphuric Acid is too weak and more Sulphuric should be used. But if it is both sparingly soluble and non-explosive, the acids are too weak to be used and should be rejected. The Nitro-Sulphuric Acid being prepared of the proper strength, immerse the cotton by small quantities at

a time. Not more than 25 grains for each ounce of mixture should be used, to prevent the cotton being too much compressed, which would develop too much heat and produce decomposition. If the warmth produced by the mixing of the Nitric and Sulphuric Acids was below 125° Fahr., it should be put in warm water and brought to that temperature.

The cotton may remain a long time in the acid mixture, but ten minutes is sufficient. The liquid should then be pressed out by means of a glass rod, and the cotton washed in an abundance of water till no traces of acid can be detected with litmus paper.

The Nitro-Sulphuric Acid can be used over again by adding to it about one-eighth of its volume of Sulphuric Acid 66°, and bringing it to the temperature of 125° Fahr.; but the cotton obtained will be inferior to the one made with fresh acids. The exact quantity of Sulphuric Acid has to be determined by experiment. Use of it as much as you can without producing compound A.

On the Different Forms of Iodizing Collodion.

The compounds used for exciting Collodion are the Iodides of Ammonium, Potassium, Cadmium, Zinc and Magnesium, and the Bromides of these same metals. The quantity which has to be used of each depends on the quantity of Iodine or Bro-

mine they contain. One part of Iodide of Potassium, for instance, will make more Iodide of Silver than one part Iodide of Cadmium, and the same of the Bromides of these two metals.

We will give here below the quantity of each Iodide and each Bromide required to make an equal quantity of Iodide and Bromide of Silver.

74 parts of Iodide of Ammonium will make as much Iodide of Silver as

75 parts Iodide of Magnesium,
83 parts Iodide of Potassium,
90 parts Iodide of Zinc, and
119 parts Iodide of Cadmium.

50 parts of Bromide of Ammonium will make as much Iodide of Silver as

51 parts Bromide of Magnesium,
59 parts Bromide of Potassium,
72 parts Bromide of Zinc,
95 parts Bromide of Cadmium.

In substituting thus one Iodide or one Bromide for another in a formula, you will have to take this into account:

If, for instance, in Mr. Humphrey's formula—

Iodide of Cadmium, 56 grains,
Bromide of Cadmium, 18 grains,

You want to substitute the Iodide and Bromide of Ammonium, you will have to use

Iodide of Ammonium, 35 grains,
Bromide of Ammonium, 10 grains,

which will yield the same amount of Iodide and Bromide of Silver as above.

The first form of iodizing below being used very much, I will give the formulæ of some other forms corresponding to it:

To 8 ounces Plain Collodion.

- Iodide of Ammonium, 32 grains,
  Bromide of Cadmium, 24 grains.
- Iodide of Potassium, 36 grains,
  Bromide of Cadmium, 24 grains.
- Iodide of Cadmium, 42 grains,
  Bromide of Cadmium, 24 grains.
- Iodide of Ammonium, 32 grains,
  Bromide of Potassium, 15 grains.
- Iodide of Potassium, 36 grains,
  Bromide of Potassium, 15 grains.
- Iodide of Cadmium, 42 grains,
  Bromide of Potassium, 15 grains.
- Iodide of Ammonium, 32 grains,
  Bromide of Ammonium, 13 grains,
- Iodide of Potassium, 36 grains,
  Bromide of Ammonium, 13 grains.
- Iodide of Cadmium, 42 grains,
  Bromide of Ammonium, 13 grains.

The Iodides of Ammonium, Cadmium, Zinc and Magnesium, and the Bromides of Cadmium, Zinc, and Magnesium are soluble in Collodion.

The Iodide of Potassium and the Bromides of Potassium and Ammonium, being almost insoluble in the mixture of Ether and Alcohol, will require to be dissolved firstly in a small quantity of water before being added to it. The water must be in such a quantity that these salts will not be precipitated in being added to the Collodion.

The most decomposable of the Iodides is the Iodide of Ammonium. It should, therefore, not be used in warm weather, except in connection with the Bromide of Cadmium, which is very stable, and in no case should it be used when the soluble cotton is acid or the Ether and Alcohol weak.

The Iodide and Bromide of Cadmium are very stable, the Iodide and Bromide of Zinc a little less so. The Iodide and Bromide of Magnesium are unstable, but less so than the Iodide of Ammonium.

It is believed by some that the Iodide of Ammonium gives more rapidity than any other iodizing. We have not found it to be so. Only Collodion iodized with it acquires its maximum of sensitiveness earlier than the one in which other iodizing is used. It has also to be borne in mind that the Iodide of Ammonium contains more Iodine than any other Iodide, and that an increase of Iodine in Collodion sometimes increases the sensitiveness.

The opinion has been advanced by several writers on Photography, that but one kind of excitants may be used in the Collodion or Nitrate bath at the time. This opinion we know, from actual experience, to be entirely without foundation, and it may be traced back to the want of attention that is paid to the quantity of Iodine and of Bromine contained in each of the salts used for exciting. If you use in your silver solution a Collodion erected with Iodide and Bromide of Magnesium, it would not do to substitute to it Iodide and Bromide of Cadmium in the same quantity. If you do, your Col-

lodion will be less iodized than the one used before, and you cannot, of course, expect to have the same result.

Mr. Moulton, in his five-dollar pamphlet, says: "If you wish to change from one Collodion to another differently excited, using the same bath, neutralize the bath with Carbonate of Soda or white caustic Potash and work it back with Glacial Acetic Acid." This, we believe, is entirely useless. The process of neutralizing your silver solution and making it acid again, will have no other effect than to add to it a little Acetate of Soda or of Potash, and if your silver solution is unfit to be used with a certain Collodion before the operation, it will be just as much so after it.

On the Fading of Positives on Paper.

The principal causes of fading are the following:

1st. Imperfect washing. It is important that the least trace of Hyposulphite of Soda should be washed out of the paper. The water giving no precipitate with Nitrate of Silver or Bichloride of Mercury, is no proof that the print is sufficiently washed.

The best method to insure perfect washing is to put the print on a heavy plate glass under a current of water, and to press it for five or ten minutes with a glass roller, then to soak it for two or three hours in clean water, taking care to change

the water every fifteen or twenty minutes. Instead of a glass roller you can use a soft sponge, which you take care to keep always saturated with water in order not to rub off the surface of the print.

2d. Too long immersion in the Hyposulphite and use of old Hyposulphite solution.

When the print remains too long a time in the Hyposulphite, the whites turn yellowish, especially when the fixing and toning bath is too old. This yellowish appearance of the whites is a commencement of fading, which will continue after the print is put up, no matter how well it has been washed. A Hyposulphite solution which fixes slowly should never be used. A print should never remain in the Hyposulphite after it is fixed, which can be seen easily in holding it up to the light. If its color is not dark enough, it may be toned darker by longer immersion, but this is at the expense of the permanency of the proof. The remedy, when a fixing and toning bath fixes quicker than it tones, is to add Chloride of Gold. When, on the contrary, it tones quicker than it fixes, it should not be used, unless it be new, in which case too much gold has been used and Hyposulphite should be added. Albumen prints should never be toned black, for they cannot be without injury.

3rd. Use of sour paste. Your paste, or Gum Arabic, should never be used if it turns sour. This can easily be detected by the smell or by means of blue litmus paper.

4th. Moisture and impure air. Moisture is always a condition favorable to decomposition.

Your prints should thus be kept in a dry place, and not hanged on a wall on which moisture sets in wet weather. The Sulphuretted Hydrogen contained in the atmosphere of cities is also a very destructive agent. It forms Sulphuret of Silver on the print, mainly when it is exposed to moisture, which Sulphuret oxydizes and is changed in Sulphate, making the print get paler and paler.

Means of Saving Large Quantities of Silver.

About one-tenth of the Silver used by photographers remains on the glass or in the paper on which the picture is made. The balance, consisting of the nine-tenths of what is used, goes into the gutter. When the Nitrate of Silver used comes to a certain amount, it would be worth the trouble to save this wasted Silver. This can be done very easily by the following means.

Develop your positive or negative picture over a barrel or bucket, so as to receive into it the developing solution which has been used. What settles on the bottom is pure metallic silver, mixed with a little iron rust.

Instead of fixing your picture by pouring the Cyanide or Hyposulphite on it, pour your fixing solution in a dish, and immerse your plate into it. This way you save your fixing solution, and, after it has dissolved so much Iodide of Silver that it has lost the power to dissolve more, pour into it a

solution of Hydrosulphate of Ammonia till all the Silver is precipitated, shaking after each addition, and allowing the Sulphuret of Silver to settle to the bottom.

This has to be done in the open air, on account of the unpleasant smell of the Hydrosulphate of Ammonia. Instead of Hydrosulphate of Ammonia, Sulphuret of Potash, or of Soda, may be used.

The Hyposulphite used for fixing positives by development has to be treated the same way.

Old silver solutions out of use may be precipitated by means of common salt.

The paper containing Silver, such as filters, prepared positive paper that has blackened, etc., can be burned and the ashes kept. Finished prints contain too small an amount of Silver to be worth keeping the ashes.

To reduce these residuums of Silver to the metallic state, dry them well, mix them all together, and to each part add one part dried Carbonate of Soda and one part Carbonate of Potash. Mix well in a mortar and put in a crucible, which you expose to white heat for about one hour. Then let the crucible become cold, break it and in the bottom you will find the metallic Silver.

Those operators who do not want to take the trouble of reducing their Silver themselves, can meet with a ready sale for their residuums.

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